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ABSTRACT

This manual provides the waste stabilization pond operator with the basics necessary for the treatment of wastewater in stabilization ponds. The material is organized as a comprehensive guide that follows the normal operation and maintenance procedures from the time the wastewater enters the left station until it leaves the pond. A comprehensive glossary of wastewater terms is included in the appendix. (CS)

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Stabilization Pond Operation and Maintenance Manual

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STABILIZATION POND
OPERATION AND
MAINTENANCE MANUAL

prepared by

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and

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for

Training Course for Stabilization Pond Operators in Minnesota, which was partially supported by a training grant #900398 from the United States Environmental Protection Agency. This type of grant is authorized under Section 104(g)(1) of the Federal Water Pollution Control Act.

Minnesota Pollution Control Agency
1935 West County Road B2
Roseville, Minnesota

1975

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SPECIAL APPRECIATION IS EXPRESSED TO THE 200 TRAINEES WHICH ATTENDED THE TRAINING COURSE AND OFFERED THEIR COMMENTS OF WHICH MANY HAVE BEEN INCORPORATED INTO THIS MANUAL.

NOTICE

THE REFERENCE TO COMMERCIAL PRODUCTS IN THIS MANUAL IS FOR ILLUSTRATION PURPOSES AND DOES NOT CONSTITUTE ENDORSEMENT BY THE MINNESOTA POLLUTION CONTROL AGENCY.

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SECTION A

INTRODUCTION

A-1 PURPOSE AND SCOPE

THIS MANUAL WAS DEVELOPED TO PROVIDE THE WASTE STABILIZATION POND OPERATOR WITH A BASIC UNDERSTANDING OF THE TREATMENT OF WASTEWATER AND IN PARTICULAR, WASTEWATER STABILIZATION PONDS. THE PURPOSE OF THE MANUAL IS TO PROVIDE A COMPREHENSIVE GUIDE FOR THE OPERATOR TO FOLLOW IN NORMAL OPERATION AND MAINTENANCE PROCEDURES. THIS MANUAL IS NOT WRITTEN TO COVER THE OPERATION FOR ALL TYPES OF PONDS, SUCH AS AERATED PONDS, EFFLUENT PONDS, OR LAGOONS. HOWEVER, MANY OF THE MAINTENANCE PRACTICES COVERED IN THIS MANUAL CAN BE USED FOR ALL TYPES OF PONDS.

A-2 MANUAL ORGANIZATION

THE MANUAL IS ORGANIZED TO FOLLOW THE NORMAL PATH OF WASTEWATER AFTER IT HAS BEEN DISCHARGED INTO THE SANITARY SEWER. THAT IS, A BASIC DESCRIPTION OF THE OPERATION AND MAINTENANCE OF THE LIFT STATION THROUGH THE STABILIZATION PONDS IS PROVIDED.

A-3 POLLUTION CONTROL STANDARDS

THROUGH THE PROCEDURES OUTLINED BY MINNESOTA STATUTES OF 1971, CHAPTERS 115 AND 116, THE MINNESOTA POLLUTION CONTROL AGENCY HAS ADOPTED STREAM STANDARDS (WPC 14 AND 15). THE STREAM AND WATER QUALITY STANDARDS WERE ESTABLISHED FOR THE

PROTECTION OF THE AQUATIC LIFE IN THE STREAM, AND FOR THE INTEREST OF PUBLIC HEALTH.

EFFLUENT QUALITY STANDARDS HAVE ALSO BEEN ESTABLISHED FOR ALL WASTEWATERS DISCHARGED TO THE SURFACE WATERS OF THE STATE. THESE STANDARDS WERE DETERMINED IN ORDER TO PREVENT THE VIOLATION OF THE WATER QUALITY STANDARDS OF A PARTICULAR STREAM. FOR WASTE STABILIZATION PONDS WHICH HAVE A CONTROLLED DISCHARGE TO PERIODS OF HIGH STREAM FLOW, THE FOLLOWING MAXIMUM ALLOWABLE EFFLUENT QUALITY STANDARDS ARE GENERALLY APPLICABLE:

BIOCHEMICAL OXYGEN DEMAND	25 MG/L
SUSPENDED SOLIDS	30 MG/L
FECAL COLIFORM GROUP ORGANISMS*	200 MPN/100 ML
PATHOGENIC ORGANISMS	NONE
TURBIDITY	25
pH RANGE	6.5 TO 8.5
OIL	ESSENTIALLY FREE OF VISIBLE OIL

PHOSPHORUS**

---

*IF IT IS EVIDENT THAT THE SYSTEM CANNOT PRODUCE THE EFFLUENT QUALITY IN REGARD TO COLIFORMS, THE PERMITTEE SHALL PROVIDE DISINFECTION FACILITIES AS MAY BE NECESSARY TO CONFORM WITH THE EFFLUENT STANDARD STATED ABOVE.

**WHERE THE DISCHARGE OF EFFLUENT IS DIRECTLY TO OR AFFECTS A LAKE OR RESERVOIR. REMOVAL OF NUTRIENTS FROM ALL WASTES SHALL BE PROVIDED TO THE FULLEST PRACTICABLE EXTENT WHEREVER SOURCES OF NUTRIENTS ARE CONSIDERED TO BE ACTUALLY OR POTENTIALLY DETRIMENTAL TO PRESERVATION OR ENHANCEMENT OF THE DESIGNATED WATER USES.

A-4 CHARACTERISTICS OF WASTEWATER

WASTEWATER IS BASICALLY THE WATER SUPPLY OF A COMMUNITY AFTER IT HAS BEEN FOULED BY VARIOUS USES.

SOURCES OF SEWAGE:

a. HUMAN AND ANIMAL WASTES;

b. HOUSEHOLD WASTES;

c. INFILTRATION OF GROUNDWATER;

d. INFLOW OF SURFACE WATERS (STORM WATER); AND

e. INDUSTRIAL WASTES OF VARIOUS KINDS.

WASTEWATER IS 99.9% WATER AND 0.1% SOLIDS; IT IS THIS 0.1% SOLIDS WHICH CREATES THE NEED FOR WASTEWATER TREATMENT.

PHYSICAL CHARACTERISTICS:

COLOR - FRESH DOMESTIC WASTEWATER IS GRAY IN COLOR (RESEMBLES DIRTY DISH WATER). HOWEVER, SEPTIC CONDITIONS OR INDUSTRIAL WASTES CAN CAUSE MANY COLOR VARIATIONS.

ODOR - FRESH DOMESTIC WASTEWATER HAS A CHARACTERISTIC OF A MUSTY ODOR.

TEMPERATURE - NORMALLY A FEW DEGREES HIGHER THAN THE WATER SUPPLY OF THE COMMUNITY (45°TO 70°).

FLOW VARIATIONS - THE SMALLER THE COMMUNITY, THE GREATER THE FLOW VARIATION. GENERALLY, FLOW IS AT A MINIMUM AFTER MIDNIGHT AND A MAXIMUM BETWEEN 7:00 A.M. AND 3:00 P.M. FOR STABILIZATION PONDS, FLOW VARIATIONS HAVE LITTLE ADVERSE EFFECT PROVIDED COLLECTION SYSTEM AND LIFT STATIONS CAN HANDLE IT.

SOLIDS - ARE BROKEN DOWN AS TO THEIR PHYSICAL CHARACTERISTICS.

DISSOLVED SOLIDS - SOLIDS WHICH BECOME PART OF THE LIQUID (MELT). ABOUT 40 TO 60% OF THE TOTAL SOLIDS LOAD OF WASTEWATER IS DISSOLVED SOLIDS.

TOTAL SUSPENDED SOLIDS - SOLIDS WHICH CONTRIBUTE ABOUT 40 TO 60% OF THE TOTAL SOLIDS LOAD. THE TOTAL SUSPENDED SOLIDS AMOUNTS TO ABOUT .2 POUNDS PER PERSON PER DAY.

A typical distribution of solids in average domestic sewage is shown in Figure 1.

CHEMICAL CHARACTERISTICS:

INORGANIC SOLIDS - WASTE MATERIALS SUCH AS SAND, SALT, IRON, CALCIUM AND OTHER RELATIVELY STABLE MATERIALS WHICH ARE NOT READILY CONSUMED BY SMALL ORGANISMS. INORGANIC WASTES ARE CHEMICAL SUBSTANCES OF MINERAL ORIGIN AND MAY CONTAIN CARBON AND OXYGEN.

ORGANIC SOLIDS - WASTE MATERIALS WHICH COME FROM ANIMAL OR VEGETABLE SOURCES. ORGANIC WASTES GENERALLY CAN BE CONSUMED BY BACTERIA AND OTHER SMALL ORGANISMS. ORGANIC WASTES CONTAIN CARBON AND HYDROGEN. THE ORGANIC PORTIONS OF WASTEWATER ARE COMPOSED LARGELY OF PROTEINS, CARBOHYDRATES AND FATS.

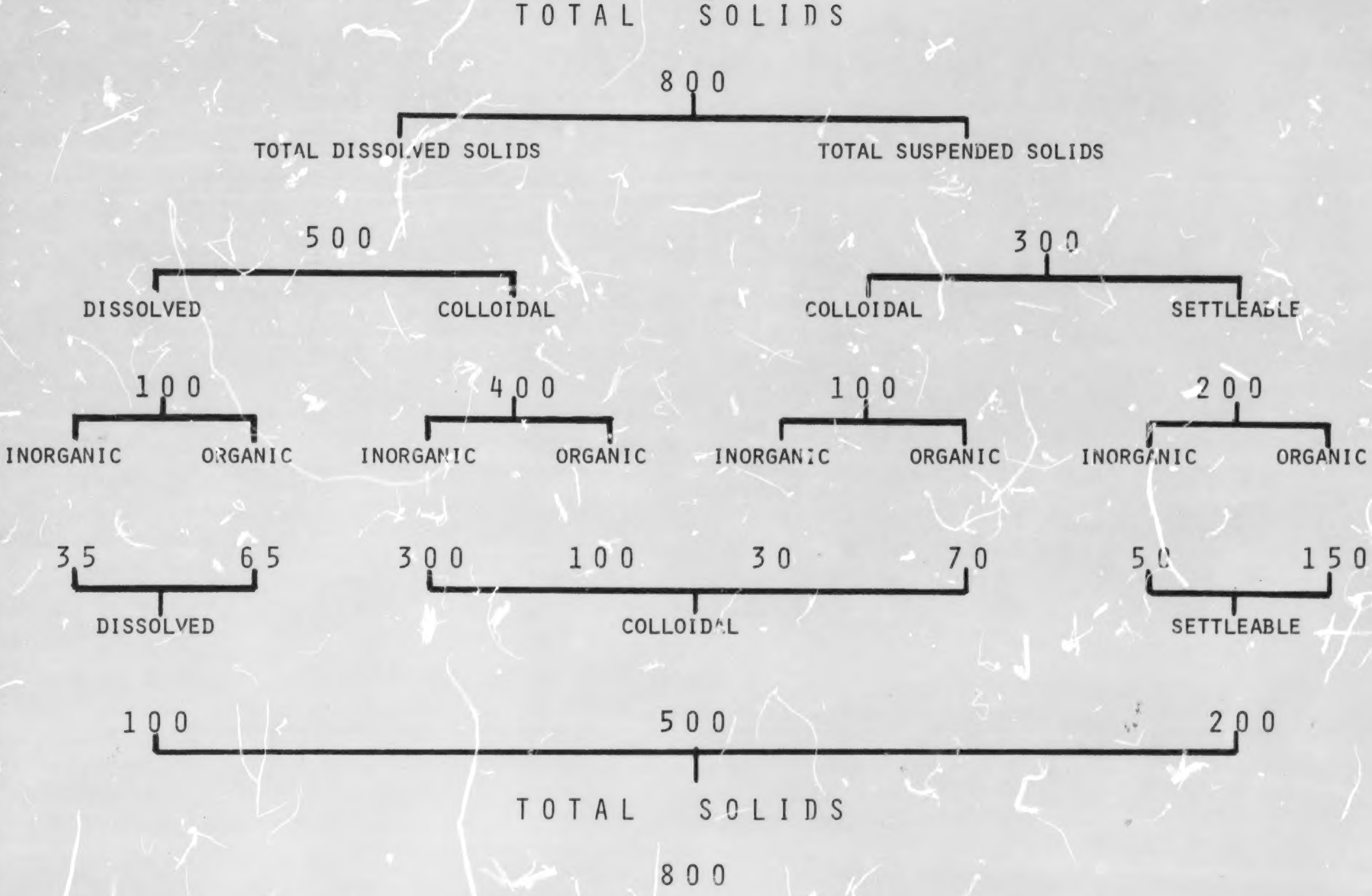
TOTAL SOLIDS
800
TOTAL DISSOLVED SOLIDS
TOTAL SUSPENDED SOLIDS
500
300
DISSOLVED
COLLOIDAL
COLLOIDAL
SETTLEABLE
100
400
100
200
INORGANIC
ORGANIC
INORGANIC
ORGANIC
INORGANIC
ORGANIC
INORGANIC
ORGANIC
35
65
300
100
30
70
50
150
DISSOLVED
COLLOIDAL
SETTLEABLE
100
500
200
TOTAL SOLIDS
800

FIGURE 1

pH - MEASURE OF HYDROGEN-ION CONCENTRATION IN LIQUID.

CHARACTERISTICS COMMONLY MEASURED:

TOTAL SUSPENDED SOLIDS - THAT PORTION OF THE TOTAL SOLIDS WHICH IS NOT DISSOLVED. THE CONCENTRATION OF INSOLUBLE MATERIALS SUSPENDED OR DISPERSED IN WASTEWATER GENERALLY EXPRESSED IN MG/L ON A DRY WEIGHT BASIS, USUALLY DETERMINED BY FILTRATION METHODS. THE AVERAGE CONCENTRATION OF TOTAL SUSPENDED SOLIDS AS DETERMINED BY THE FILTRATION METHOD FOR DOMESTIC WASTEWATER IS 220-280 MG/L.

VOLATILE SUSPENDED SOLIDS - GENERALLY REFERS TO THE ORGANIC CONTENT. IN TESTING, ONLY THE VSS PORTION OF THE TSS IS MEASURED. IT REPRESENTS THE QUANTITY OF SOLIDS IN WATER THAT REPRESENTS A LOSS IN WEIGHT UPON IGNITION AT 550° C.

BIOCHEMICAL OXYGEN DEMAND (BOD) - THE NORMAL OXYGEN DEMAND, BOD_5, AS DETERMINED BY THE 5-DAY BOD TEST, OF AVERAGE DOMESTIC WASTEWATER IS 200-250MG/L. THIS IS A MEASURE OF THE STRENGTH OF THE WASTEWATER AND INDICATES THE QUANTITY OF OXYGEN REQUIRED FOR BIOCHEMICAL OXIDATION OF A GIVEN WASTE AT A GIVEN TIME AND A GIVEN TEMPERATURE (COMPLETE OXIDATION WOULD TAKE OVER 100 DAYS). EACH PERSON CONTRIBUTES, ON THE AVERAGE, 0.17 POUNDS OF BOD PER DAY.

pH - IF THE pH IS NOT WITHIN THE 6.0-9.0 RANGE BIOLOGICAL ACTIVITIES CAN BE INHIBITED.

BIOLOGICAL CHARACTERISTICS:

MICROORGANISMS - ORGANISMS NOT VISIBLE TO THE NAKED EYE.

BACTERIA - MINUTE LIVING ORGANISMS, MICROSCOPIC IN SIZE, WHICH CONSIST OF SINGLE CELLS AND ARE SIMILAR IN FUNCTION AND LIFE PROCESSES TO PLANTS. THE TOTAL BACTERIA IN WASTEWATER RANGES FROM 2 TO 20 MILLION PER CUBIC CENTIMETER. A CUBIC CENTIMETER IS ABOUT AN EYE-DROPPER FULL OR 20 DROPS.

PARASITIC BACTERIA - LIVING AT THE EXPENSE OF A HOST AND DEPEND UPON THE HOST FOR FOOD AND PROPER ENVIRONMENTAL CONDITIONS.

PATHOGENIC BACTERIA - DURING GROWTH WITHIN BODY OF THE HOST, PRODUCE TOXIC OR POISONOUS COMPOUNDS THAT CAUSE DISEASE IN THE HOST. (TYPHOID FEVER, DYSENTERY, CHOLERA, ETC.)

SAPROPHYTIC BACTERIA - FEED ON DEAD ORGANIC MATTER. UTMOST IMPORTANCE IN WASTEWATER TREATMENT METHODS; THEY ARE THE WORKERS IN WASTEWATER TREATMENT. ALL OF THE BACTERIA, PARASITIC AND SAPROPHYTIC, REQUIRE IN ADDITION TO FOOD, OXYGEN FOR RESPIRATION.

OTHER MICROSCOPIC ORGANISMS - OTHER ORGANISMS TOO SMALL TO BE SEEN WITHOUT A MICROSCOPE ARE PRESENT

IN BOTH PLANT AND ANIMAL FORMS. THEY AID IN DECOMPOSITION; HOWEVER, THEY ARE NOT AS ABUNDANT AS BACTERIA.

VIRUSES - DO NOT PLAY A PART IN TREATMENT; HOWEVER, LIKE PATHOGENIC BACTERIA, THEY ARE THE CAUSATIVE AGENT OF A NUMBER OF DISEASES IN MAN.

EXAMPLE: Hepatitis

MACROSCOPIC ORGANISMS - ARE LARGER, MORE COMPLEX ORGANISMS VISIBLE TO THE NAKED EYE, WHICH PLAY A PART IN THE DECOMPOSITION OF ORGANIC MATTER.

ADDITIONAL SOURCES OF INFORMATION:

NEW YORK MANUAL, CHAPTER I
TEXAS MANUAL, CHAPTER I
WPCF, MOP II, CHAPTER 2
SACRAMENTO STATE HOME-STUDY COURSE, CHAPTER 2

SECTION B

LIFT STATION AND COLLECTION SYSTEM

B-1 GENERAL

WASTEWATER IS CONVEYED TO THE PRIMARY CELL OF A STABILIZATION POND BY EITHER A LIFT STATION AND FORCE MAIN OR BY A GRAVITY SEWER. ONLY IN RARE INSTANCES IS THE WASTEWATER COLLECTED AND CONVEYED TO THE PONDS BY GRAVITY; THUS THE PUMPING STATION IS AN IRREPLACEABLE LINK IN THE SYSTEM. THE FOLLOWING IS A BRIEF SUMMARY OF THE OPERATION AND MAINTENANCE PROCEDURES FOR THESE SYSTEMS.

B-2 TYPES OF LIFT STATIONS

LIFT STATION CONSTRUCTION MAY BE CLASSIFIED INTO TWO GENERAL CLASSES - WET WELL AND WET WELL-DRY WELL COMBINATIONS.

BASICALLY, THE FOLLOWING ARE THE MOST COMMON TYPES OF PUMPING SYSTEMS IN USE TODAY:

1. EJECTOR LIFT STATION
    - (a) USED FOR RELATIVELY LOW FLOWS
    - (b) REQUIRES COMPRESSED AIR
    - (c) AUTOMATICALLY CONTROLLED
2. LIFT STATIONS UTILIZING SUBMERSIBLE PUMPS
    - (a) RELATIVELY LOW FLOWS
    - (b) NO DRY WELL REQUIRED
    - (c) MAINTENANCE RELATIVELY SIMPLE

3. SUCTION LIFT PUMP STATIONS
    (a) USED FOR RELATIVELY LOW FLOWS
    (b) USUALLY NOT EXCEEDING 15 FOOT LIFT
4. CENTRIFICAL PUMPING STATIONS
    (a) CAPACITY FOR LARGE VOLUMES
    (b) MINIMAL MAINTENANCE PROBLEMS.

ALL OF THE ABOVE TYPES OF PUMPING STATIONS MAY BE FACTORY BUILT OR FIELD CONSTRUCTED.

B-3 LIFT STATION OPERATION AND MAINTENANCE

THE PUMPS IN A LIFT STATION CONVEY THE WASTEWATER VIA A FORCE MAIN UNDER PRESSURE TO THE PRIMARY CELL OF THE STABILIZATION PONDS. THE PUMPS IN A LIFT STATION SHOULD BE DESIGNED IN A MANNER AS TO ALLOW THE OPERATOR TO MAINTAIN AND REPAIR THE EQUIPMENT WITHOUT TAKING THE LIFT STATION OUT OF SERVICE. IT SHOULD BE REMEMBERED THAT ALL TYPES OF LIFT STATIONS REQUIRE DAILY INSPECTION AND SHOULD BE INCLUDED IN A PREVENTATIVE MAINTENANCE SCHEDULE TO PRECLUDE OPERATIONAL PROBLEMS AND BREAKDOWNS.

THE MAINTENANCE OF THE LIFT STATION ENTAILS THE FOLLOWING:

1. GENERAL CLEAN UP;
2. LUBRICATION, ACCORDING TO MANUFACTURERS' RECOMMENDATIONS;
3. CHECKING THE AMOUNT OF PUMPING TIME ON EACH PUMP TO ENSURE EQUAL OPERATING TIME;
4. REMOVAL OF ANY DEBRIS THAT MAY ACCUMULATE IN THE WET WELL
5. CLEANING OF FLOATS AND ELECTRODES;

6. INSPECTION OF CHECK VALVES.

BAR RACKS AND COMMINUTION

GENERALLY, PUMPS HANDLING RAW WASTEWATER SHOULD BE PRECEDED BY A BAR RACK OR BASKET WITH OPENINGS IN THE 2 INCH RANGE. IN SOME SITUATIONS THE USE OF COMMINUTION DEVICES (COMMINUTORS, BARMINUTORS) MAY BE INCORPORATED. THE PURPOSE OF SUCH PRETREATMENT DEVICES IS FOR PROTECTION OF PUMPS AND VALVES, THEREBY REDUCING REPAIRS AND REPLACEMENTS OF FURTHER TREATMENT EQUIPMENT.

BAR RACK AND BASKET CLEANING SHOULD BE INCLUDED ON A REGULAR SCHEDULE, SO THAT THEIR DESIGN FUNCTION IS REALIZED AND SO THAT CLOGGING AND POSSIBLE SEWER BACK-UP DOES NOT OCCUR.

SCREENINGS FROM BAR RACKS AND BASKETS SHOULD BE STORED AND DISPOSED OF PROPERLY TO ELIMINATE ODOR PROBLEMS. USUALLY FINAL DISPOSAL IS BY BURIAL IN A LOCAL LANDFILL OR BY INCINERATION IN PROPER INCINERATION UNITS.

COMMINUTING DEVICES SHOULD BE CHECKED REGULARLY AND MAINTAINED IN ACCORDANCE WITH MANUFACTURERS' RECOMMENDATIONS TO ENSURE PROPER OPERATION.

DEHUMIDIFICATION

THE UTILIZATION OF DEHUMIDIFIERS TO REDUCE MOISTURE IN LIFT STATIONS IS OFTEN OVERLOOKED. MOISTURE REDUCTION WITHIN THE LIFT STATION SHOULD APPRECIABLY REDUCE THE CORROSION PROBLEM EXPERIENCED IN LIFT STATIONS WITHOUT DEHUMIDIFIERS.

DRY WELL DEWATERING

A SEPARATE SUMP PUMP SHOULD BE PROVIDED IN THE DRY WELL TO REMOVE LEAKAGE OR DRAINAGE FROM THE DRY WELL FLOOR. THEREFORE, ALL DRY WELL FLOOR AND WALKWAY SURFACES SHOULD HAVE AN ADEQUATE SLOPE TO DRAIN TO THE SUMP PUMP COLLECTION POINT. THE SUMP PUMP DISCHARGE SHOULD BE TO THE WET WELL AT A POINT ABOVE THE ATTAINABLE WATER LEVEL.

B-4 EMERGENCY OPERATION

THE OBJECTIVE OF EMERGENCY OPERATION OF A LIFT STATION IS TO PREVENT THE DISCHARGE OF RAW WASTEWATER TO ANY WATER OF THE STATE AND TO PROTECT PUBLIC HEALTH BY PREVENTING THE BACK-UP OF WASTEWATER TO BASEMENTS, STREETS, OR OTHER PUBLIC PROPERTY.

STANDBY POWER SUPPLY

PROVISION OF AN EMERGENCY POWER SUPPLY FOR LIFT STATIONS MAY BE ACCOMPLISHED BY THE FOLLOWING MEANS:

(a) BY CONNECTION OF THE LIFT STATION TO AT LEAST 2 INDEPENDENT PUBLIC UTILITY SOURCES.

(b) BY PROVISION OF PORTABLE OR IN-PLACE INTERNAL COMBUSTION ENGINE EQUIPMENT WHICH WILL GENERATE ELECTRICAL OR MECHANICAL ENERGY.

(c) BY PROVISION OF PORTABLE PUMPING EQUIPMENT.

STANDBY POWER UNITS SHOULD BE PLACED IN OPERATION FOR A SHORT PERIOD EVERY TWO WEEKS TO INSURE AVAILABILITY WHEN NEEDED.

ALARM SYSTEMS

IT WOULD BE ADVISABLE TO HAVE ALARM SYSTEMS FOR LIFT STATIONS. THIS ALARM SYSTEM WOULD BE ACTIVATED IN CASES OF POWER FAILURE, PUMP FAILURE, OR ANY CAUSE OF LIFT STATION MALFUNCTION. IF IT IS POSSIBLE, ALARMS SHOULD BE TELEMETERED TO A CENTRAL POINT WHERE 24-HOUR ATTENDANCE IS AVAILABLE.

MANY OF THE DIFFICULTIES IN THE OPERATION OF A LIFT STATION CAN BE CAUSED BY THE ELECTRICAL SYSTEM. THEREFORE, THE OPERATOR SHOULD LEARN AS MUCH AS POSSIBLE ABOUT THE FUNCTIONS OF THE ELECTRICAL SYSTEM.

B-5 LIFT STATION VENTILATION

ADEQUATE VENTILATION SHOULD BE PROVIDED FOR ALL LIFT STATIONS. WHEN THE PUMP STATION IS BELOW THE GROUND, MECHANICAL VENTILATION IS REQUIRED TO INDEPENDENTLY VENTILATE THE DRY WELL AND WET WELL. SAFETY PROCEDURES WILL BE COVERED IN SECTION I OF THIS MANUAL.

B-6 FLOW MEASUREMENT AND METERING

IT IS OBVIOUS THAT A COMMUNITY SHOULD KNOW WITH REASONABLE ACCURACY THE AMOUNT OF WASTEWATER IT IS TREATING, AS A NECESSARY BASIS FOR:

(a) COMPUTING OPERATING COSTS;

(b) FOR DETERMINING SPRING AND FALL DISCHARGES ;

(c) DETERMINING SEEPAGE LOSSES ;

(d) ESTIMATING FUTURE EXPANSION ;

(e) FOR MONTHLY REPORTING;

(f) EVALUATING TREATMENT EFFICIENCY.

FOR THESE REASONS, THE MINNESOTA POLLUTION CONTROL AGENCY (MPCA) IS REQUIRING SOME TYPE OF MEASURING DEVICE AND FLOW RECORDER AT ALL STABILIZATION PONDS.

THE MOST COMMON METHOD USED IN DETERMINING THE FLOW TO A WASTE STABILIZATION POND IS THE RUNNING TIME OF THE PUMPS IN THE LIFT STATION. THE FLOW IS CALCULATED BY MULTIPLYING THE TOTAL MINUTES LOGGED ON EACH PUMP BY THE VOLUME THE PUMP WILL PUMP IN ONE MINUTE. THE VOLUMES OF BOTH PUMPS SHOULD THEN BE ADDED TO OBTAIN THE TOTAL FLOW.

Figure 3 shows a sample pump log sheet.

ANOTHER COMMON TYPE OF FLOW MEASUREMENT DEVICE USED IN STABILIZATION PONDS IS THE SHARP CRESTED WEIR, SUCH AS THE V-NOTCH OR RECTANGULAR WEIR. HOWEVER, A LEVEL RECORDER MUST BE USED WITH EACH OF THESE WEIRS.

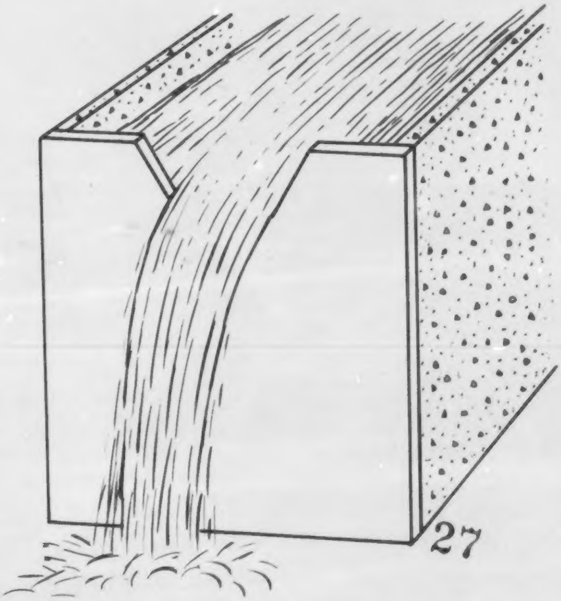

Figure 2

PUMP RUNNING TIME
AND FLOW RECORD

DATE:

Date	PUMP NO. 1		PUMP NO. 2		Total Minutes 1 + 2	Flow (gal)	gal
	Reading	Minutes	Reading	Minutes			Minutes
31							
30							
29							
28							
27							
26							
25							
24							
23							
22							
21							
20							
19							
18							
17							
16							
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13							
12							
11							
10							
9							
8							
7							
6							
5							
4							
3							
2							
1							

FIGURE 3

THE V-NOTCH WEIR IS USED IN MEASURING RELATIVELY SMALL RATES OF DISCHARGE, USUALLY UNDER 900 GPM.

Figure 5 gives the discharge in gpm at various heads.

(b) RECTANGULAR WEIR-STANDARD END CONTRACTION:

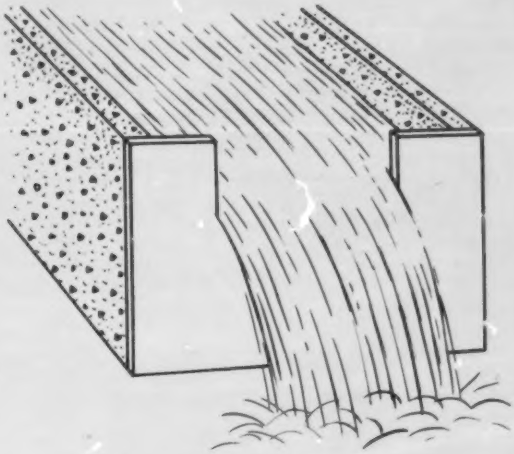


Figure 4

THE RECTANGULAR WEIR IS USED FOR FLOWS GREATER THAN 900 GPM.

figure 6 gives the discharge data in gpm for rectangular weirs.

THERE ARE MANY OTHER METHODS OF MEASURING LIQUIDS FLOWING IN OPEN CHANNELS AND IN PIPES. FOR EXAMPLE, A MAGNETIC FLOWMETER, PARSHALL FLUME, OR VENTURI TUBE TO NAME A FEW. HOWEVER, AN IN-DEPTH DISCUSSION OF THESE WILL NOT BE PRESENTED IN THIS MANUAL.

B-7 INFLUENT SEWER OPERATION

RAW WASTEWATER ENTERS THE PRIMARY CELL VIA A FORCE MAIN OR

FIGURE 5

DISCHARGE OVER 90° V-NOTCH WEIR

Head (H) Inches	Discharge gallons per minute (gpm)
1	2
1/4	4
1/2	6
3/4	9
2	12
1/4	17
1/2	24
3/4	30
3	37
1/4	45
1/2	53
3/4	65
4	76
1/4	88
1/2	100
3/4	114
5	129
1/4	149
1/2	166
3/4	183
6	204
1/4	225
1/2	247
3/4	276
7	300
1/4	332
1/2	354
3/4	383
8	413
1/4	451
1/2	486
3/4	684
9	555
1/4	594
1/2	632
3/4	684
10	725
1/2	815

Head (H)	Discharge gallons per minute (gpm)
11	910
1/2	1040
12	1130
1/2	1250
13	1380
1/2	1520
14	1650
1/2	1810
15	1970
1/2	2120
16	2310
1/2	2480
17	2670
1/2	2880
18	3080
1/2	3290
19	3530
1/2	3760
20	4000
1/2	4250
21	4500
1/2	4770
22	5060
1/2	5340
23	5640
1/2	5950
24	6280
1/2	6580
25	6900

DISCHARGE OVER RECTANGULAR WEIR WITH STANDARD END CONTRACTIONS

Discharge -- Gallons per minute (GPM)

Head (H) Inches	Length of Weir (L) Inches										
	2	4	6	8	10	12	15	18	24	36	60
1/4	1	2	2	3	4	5	6	7	10		
1/2	2	4	6	9	11	13	16	19	26		
3/4	4	8	12	16	19	23	29	35	46		
1	6	12	18	24	30	36	45	54	72	108	180
1/4		17	25	33	42	50	63	76	100	150	250
1/2		22	33	44	55	66	83	99	132	197	330
3/4		28	42	55	69	83	104	124	166	248	415
2		34	51	68	85	101	127	152	202	303	505
1/4			61	81	101	121	152	183	242	363	605
1/2			71	95	118	142	178	213	284	426	710
3/4			82	109	136	164	205	246	328	492	820
3			93	124	155	187	233	280	374	561	935
1/4				140	176	210	263	316	420	630	1050
1/2				157	197	235	294	353	470	705	1180
3/4				174	218	261	326	392	522	783	1310
4				190	239	287	358	431	574	861	1430
1/4					262	314	393	472	628	942	1570
1/2					285	343	429	515	686	1030	1710
3/4					310	374	465	559	748	1120	1860
5					334	403	500	605	806	1210	2010
1/4						433	540	650	866	1300	2160
1/2						464	580	695	928	1390	2320
3/4						495	620	745	992	1480	2480
6						528	660	791	1050	1580	2640
1/4							701	842	1120	1680	2800
1/2							743	893	1190	1790	2980
3/4							785	945	1260	1890	3150
7							830	1000	1330	1990	3320
1/4							875	1050	1400	2100	3500
1/2							920	1100	1470	2200	3680
3/4								1160	1540	2310	3350
8								1210	1620	2430	4050
1/4								1270	1700	2550	4250
1/2								1340	1780	2670	4450
3/4								1400	1860	2790	4650
9								1460	1940	2910	4850
1/4									2020	3030	5050
1/2									2100	3150	5250
3/4									2180	3270	5450
10									2270	3400	5670
1/2									2450	3680	6120

FIGURE 6

A GRAVITY SEWER. IN BOTH CASES THE WASTEWATER SHOULD BE DISCHARGED APPROXIMATELY IN THE CENTER AND AT THE BOTTOM OF THE PRIMARY CELL.

BOTTOM/CENTER DISCHARGES DISCOURAGE SHORT CIRCUITING, ENHANCE DISPERSION OF SOLIDS THROUGHOUT PRIMARY CELLS, AND CONSERVES HEAT, ALL OF WHICH ARE ESSENTIAL FOR GOOD BIOLOGICAL ACTIVITY. HEAT CONSERVATION IS ESPECIALLY IMPORTANT DURING WINTER MONTHS WHEN BIOLOGICAL ACTIVITIES ARE AT A MINIMUM. IF DISCHARGE WAS AT THE SURFACE DURING THE WINTER MONTHS, WASTEWATER WOULD BE DISCHARGED ONTO THE ICE, THUS ELIMINATING DILUTION, RETARDING DECOMPOSITION AND POSSIBLY CREATING SEPTIC CONDITIONS.

B-8 INFLUENT SEWER MAINTENANCE

WHEN THE FORCE MAIN IS UNUSUALLY LONG, IT MAY BE DESIGNED LARGER THAN NORMAL TO REDUCE HEAD LOSS DUE TO FRICTION AND TO HELP DECREASE PUMPING COSTS. THEREFORE, IT MAY BE ADVISABLE TO OCCASIONALLY TURN ON ALL THE PUMPS IN THE LIFT STATION IN ORDER TO INCREASE THE VELOCITY OF FLOW IN THE FORCE MAIN TO HELP SCOUR DEPOSITS OF SEWAGE SOLIDS WHICH HAVE ACCUMULATED DURING PERIODS OF LOW FLOW OR LOW VELOCITY.

IF WASTEWATER FLOW TO THE PONDS IS BY GRAVITY SEWER, THE PORTION OF SEWER FROM THE DIKE TO THE CENTER OF THE POND IS USUALLY SUBMERGED. THIS INFLUENT LINE WILL ALSO ACCUMULATE SEWAGE SOLIDS, AND SHOULD OCCASIONALLY BE FLUSHED OUT BY CLOSING THE GATE ON THE LINE AT THE DIKE AND BACKING WASTEWATER INTO THE OUTFALL SEWER OF THE POND AND THEN SUDDENLY OPENING IT TO CREATE A SURGE OF FLOW.

ADDITIONAL SOURCES OF INFORMATION:

- WPCF, MOP #1, OPERATION OF WASTEWATER TREATMENT PLANTS, CHAPTER 3
- TEXAS MANUAL, CHAPTERS 6, 7, AND 8.
- WPCF, MOP #7, SEWER MAINTENANCE
- EQUIPMENT OPERATION AND MAINTENANCE INSTRUCTIONS AS PROVIDED BY MANUFACTURER.
- OPERATION AND MAINTENANCE MANUAL PROVIDED BY ENGINEER.
- PUMPS AND PUMPING, WATER AND WASTES ENGINEERING.
- WASTEWATER PLANT OPERATORS MANUAL, WASHINGTON, CHAPTER 3 AND 4

SECTION C

TREATMENT PROCESS

C-1 BACKGROUND

ALTHOUGH THE USE OF STABILIZATION PONDS AS A METHOD OF TREATING DOMESTIC WASTEWATER AND INDUSTRIAL WASTE IS RELATIVELY NEW WHEN COMPARED WITH OTHER FORMS OF TREATMENT, HUNDREDS HAVE BEEN CONSTRUCTED IN MINNESOTA, AND THEIR USE HAS PROGRESSED TO THE POINT THAT WHEN PROPERLY DESIGNED AND OPERATED, A STABILIZATION POND WILL PRODUCE AN EFFLUENT WELL WITHIN THE STANDARDS AS REQUIRED BY THE MINNESOTA POLLUTION CONTROL AGENCY.

THE BIOLOGICAL STABILIZATION OF SEWAGE IN A NATURAL POND OR LAKE IS NOT A NEW PHENOMENON ANY MORE THAN IS THE BIOLOGICAL STABILIZATION (SELF PURIFICATION) PROCESS WHICH OCCURS IN A FLOWING STREAM. IN BOTH BODIES OF WATER, THE STABILIZATION OF WASTEWATER HAS BEEN OBSERVED TO TAKE PLACE UNDER AEROBIC AND ANAEROBIC CONDITIONS. IN DESIGNING A CONVENTIONAL WASTEWATER TREATMENT PLANT, ENGINEERS ATTEMPT TO PROVIDE CONDITIONS UNDER WHICH THE PROCESS OF BIOLOGICAL STABILIZATION, WHICH WOULD OTHERWISE OCCUR IN PERHAPS SEVERAL MILES OF RAPIDLY FLOWING STREAM, WILL BE CARRIED OUT IN AN ENVIRONMENT BOUNDED BY CONCRETE, STEEL, AND MECHANICAL DEVICES. SIMILARLY, THE STABILIZATION OF WASTEWATER WHICH OCCURS IN A NATURAL POND OR LAKE MAY ALSO BE CARRIED OUT IN A MAN-MADE POND OR LAKE UNDER CONTROLLED CONDITIONS.

BOTH THE SO-CALLED CONVENTIONAL MECHANICAL WASTEWATER TREATMENT PLANT AND THE STABILIZATION POND ACCOMPLISH THE SAME END RESULT. THIS RESULT IS THE PROTECTION OF OUR NATURAL STREAMS AND LAKES FROM POLLUTION AND DEGRADATION FROM DISCHARGE OF UNTREATED SEWAGE AND INDUSTRIAL WASTE. HOWEVER, BOTH OF THESE GENERAL METHODS OF WASTEWATER TREATMENT ARE SUBJECT TO FAILURE BY OVERLOADING AND IMPROPER DESIGN, RESULTING IN POOR TREATMENT AND POSSIBLE ODOR NUISANCE. STABILIZATION PONDS OR LAGOONS ARE NOT JUST *"HOLES IN THE GROUND"* AS SOME PEOPLE SEEM TO THINK, BUT ARE CAREFULLY DESIGNED AND CONSTRUCTED TO DO A SPECIFIC JOB OF WASTEWATER TREATMENT, PROVIDED THEY ARE OPERATED PROPERLY.

C-2 HISTORY

FESSENDEN, NORTH DAKOTA, WAS THE FIRST MUNICIPALITY IN THE NORTHERN PART OF THE UNITED STATES TO USE A STABILIZATION POND FOR WASTEWATER TREATMENT. THIS POND WAS DEVELOPED IN 1928 FROM A NATURAL POND AREA. MADDOCK, NORTH DAKOTA DESIGNED AND CONSTRUCTED THE FIRST POND IN THE UPPER MIDWEST IN 1949 FOR TREATMENT OF RAW WASTEWATER. THE SUCCESS OF THIS INSTALLATION AND THE MANY OTHERS NOW IN USE IN THE NATION, HAS LED TO THE PRESENT WIDE ACCEPTANCE OF STABILIZATION PONDS AS A SATISFACTORY METHOD OF WASTEWATER TREATMENT.

THE FIRST INSTALLATION IN MINNESOTA WAS PLACED IN OPERATION AT ALBANY IN 1955. PLANS AND SPECIFICATIONS FOR THE ORIGINAL INSTALLATION AT ALBANY, WARREN, AND BRECKENRIDGE, WERE APPROVED BY

THE STATE WATER POLLUTION CONTROL COMMISSION, THE PREDECESSOR OF THE MINNESOTA POLLUTION CONTROL AGENCY, WITH THE UNDERSTANDING THAT THEY WERE TO BE CONSIDERED ON AN EXPERIMENTAL BASIS AND THAT DESIGN CHANGES MIGHT BE REQUIRED IF THE PONDS DID NOT OPERATE IN A SATISFACTORY MANNER.

THE INSTALLATION AT ALBANY WAS OF SPECIAL INTEREST BECAUSE MILK WASTE CONSTITUTED ABOUT 75 PERCENT OF THE TOTAL STRENGTH OF THE WASTEWATER DISCHARGED TO IT. A DETAILED STUDY OF THE OPERATION OF THE ALBANY PONDS WAS MADE BY THE MINNESOTA DEPARTMENT OF HEALTH, SECTION OF WATER POLLUTION CONTROL DURING THE FIRST YEAR AND A HALF OF ALBANY'S POND OPERATION. RESULTS OF THE ANALYSES OF SAMPLES COLLECTED FROM THE PONDS TOGETHER WITH PHYSICAL OBSERVATIONS SHOWED THAT THEIR OPERATION WAS SATISFACTORY, BASED ON CONFORMANCE TO DESIGN CRITERIA. TREATMENT RESULTS AT ALBANY AND SUBSEQUENT INSTALLATIONS WERE SUFFICIENTLY FAVORABLE SO THAT STABILIZATION PONDS ARE NO LONGER CONSIDERED TO BE ON AN EXPERIMENTAL BASIS BUT ARE APPROVED ON THE SAME BASIS AS THOSE FOR CONVENTIONAL MECHANICAL TREATMENT PLANTS.

AT PRESENT, THERE ARE OVER 200 STABILIZATION POND PROJECTS COMPLETED OR UNDER CONSTRUCTION IN MINNESOTA. THESE INSTALLATIONS RANGE CONSIDERABLY IN SIZE FROM A TOTAL OF ABOUT 335 ACRES TO LESS THAN 1 ACRE. IT APPEARS THAT ABOUT 10 ADDITIONAL MUNICIPALITIES EACH YEAR WILL BE CONSTRUCTING STABILIZATION PONDS AS A SOLE METHOD OF TREATMENT.

C-3 PROCESS DESCRIPTION

WHAT IS A STABILIZATION POND?

A STABILIZATION POND IS A MAN-MADE FACILITY IN WHICH NATURAL PURIFICATION PROCESSES OCCUR UNDER CONTROLLED CONDITIONS. IF A STABILIZATION POND OR OTHER METHOD OF TREATMENT WERE NOT PROVIDED, THIS PURIFICATION PROCESS WOULD TAKE PLACE IN A NATURAL POND, LAKE OR SEVERAL MILES OF RAPIDLY FLOWING STREAM. BY PROVIDING STABILIZATION PONDS, THE DEGRADATION AND POLLUTION OF THESE SURFACE WATERS CAN BE PREVENTED.

STABILIZATION PONDS IN USE TODAY SHOULD NOT BE CONFUSED WITH AERATED STABILIZATION PONDS, EFFLUENT POLISHING PONDS OR INDUSTRIAL WASTE STORAGE LAGOONS.

AERATED STABILIZATION PONDS USE THE BASIC CONCEPT OF STABILIZATION PONDS; HOWEVER, MECHANICAL OR DIFFUSED AIR IS INDUCED INTO THE WASTEWATER TO AID IN THE TREATMENT PROCESS. IN ADDITION, AERATED PONDS GENERALLY HAVE A CONTINUOUS DISCHARGE.

INDUSTRIAL WASTE STORAGE LAGOONS ARE USED FOR STORAGE OF WASTES FROM PROCESSING OPERATIONS SUCH AS VEGETABLE CANNERIES, BEET SUGAR PLANTS, ETC. THE WASTE STORED IN THESE SYSTEMS IS GENERALLY OF HIGH STRENGTH AND OFTEN TIMES ASSOCIATED WITH ODOR NUISANCES. TREATMENT IS NOT USUALLY ACCOMPLISHED IN THE LAGOON BUT IS LATER REALIZED BY PROCESS SUCH AS LAND APPLICATION OR DILUTION BLEEDING DURING HIGH FLOW PERIODS.

EFFLUENT POLISHING PONDS ARE DESIGNED LIKE WASTEWATER

STABILIZATION PONDS EXCEPT FOR HAVING SHORTER DETENTION TIMES. THEY GENERALLY FOLLOW A SECONDARY TREATMENT FACILITY AND ARE DESIGNED TO PROVIDE ADDITIONAL REMOVAL OF BOD AND SUSPENDED SOLIDS. EFFLUENT POLISHING PONDS ARE LOADED AT CONSIDERABLY SMALLER ORGANIC LOADING PER ACRE THAN ARE STABILIZATION PONDS.

THE TERM *"STABILIZATION POND"* WILL BE USED TO DESCRIBE THE PROCESS WE ARE CONCERNED WITH THROUGHOUT THIS MANUAL.

STABILIZATION PONDS IN MINNESOTA ARE GENERALLY SPOKEN OF AS AEROBIC PONDS. ACTUALLY HOWEVER, THEY OPERATE IN A FACULTATIVE MANNER, AS BOTH AEROBIC AND ANAEROBIC CONDITIONS MAY EXIST IN A NORMAL POND SYSTEM.

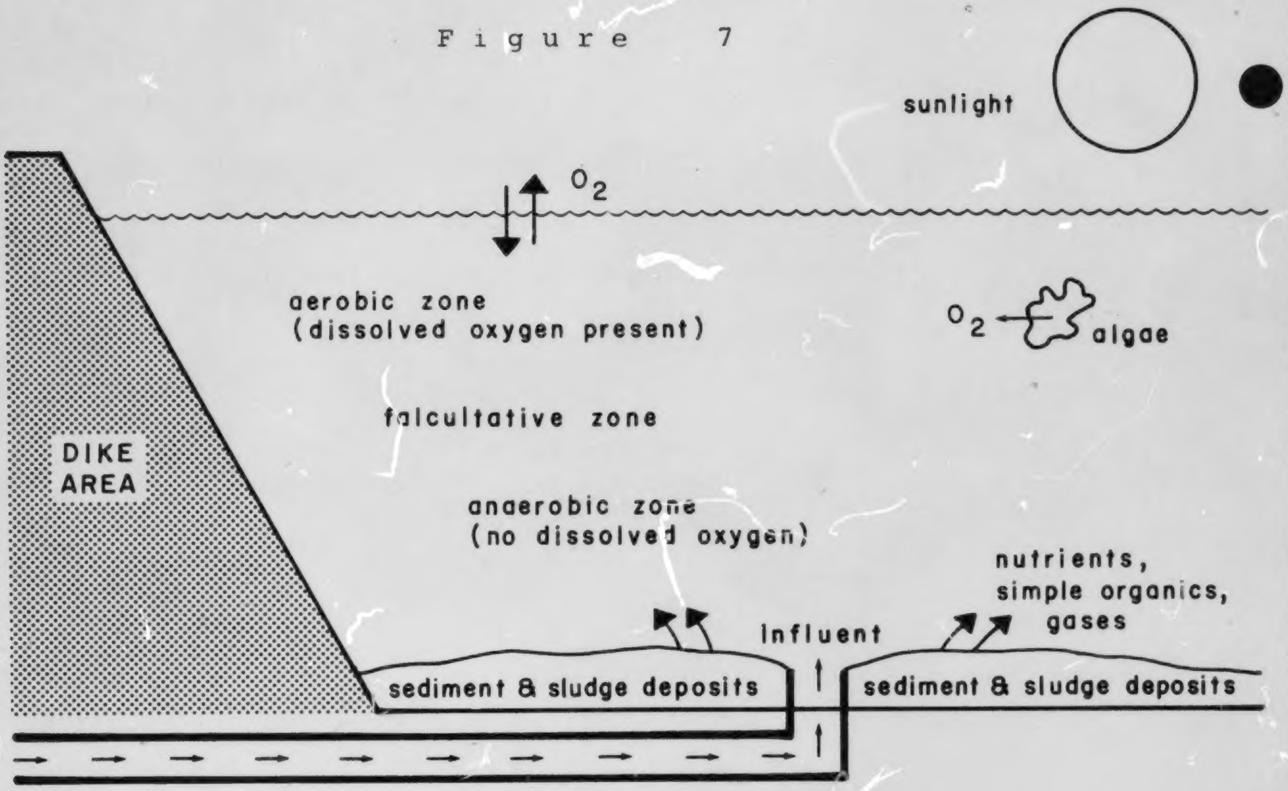
A. *AEROBIC ORGANISMS* UTILIZE DISSOLVED OXYGEN FOR THEIR LIFE PROCESSES.

B. *ANAEROBIC ORGANISMS* UTILIZE COMBINED OXYGEN FOR THEIR LIFE PROCESSES.

C. *FACULTATIVE ORGANISMS* CAN UTILIZE DISSOLVED OXYGEN OR COMBINED OXYGEN BECAUSE THEY CAN ADAPT TO CHANGING OXYGEN CONDITIONS AND CONTINUE DECOMPOSITION WHILE THE SYSTEM CHANGES FROM AEROBIC TO ANAEROBIC OR ANAEROBIC TO AEROBIC EXTREMES.

THE FOLLOWING DIAGRAM ILLUSTRATES THIS ZONAL ORGANISM RELATIONSHIP IN A STABILIZATION POND.

Figure 7


sunlight
O_2
aerobic zone
(dissolved oxygen present)
O_2
algae
falcultative zone
DIKE
AREA
anaerobic zone
(no dissolved oxygen)
nutrients,
simple organics,
gases
influent
sediment & sludge deposits
sediment & sludge deposits

THE LEVEL OF THE AEROBIC ZONE FLUCTUATES WITH MANY ENVIRONMENTAL FACTORS. FOR EXAMPLE, DURING SUMMER MONTHS WITH MAXIMUM OXYGEN PRODUCTION FROM ALGAE AND SURFACE WIND ACTION, THE AEROBIC ZONE MAY APPROACH THE ENTIRE DEPTH OF THE POND. WHEREAS, UNDER ICE COVER WHEN OXYGEN IS DEPLETED, THE ANAEROBIC ZONE MAY OCCUPY THE ENTIRE POND.

THE SLUDGE LAYER (IN A BALANCED POND SYSTEM) IS ANAEROBIC. GAS AND OTHER BYPRODUCTS USUALLY CONSIDERED OBJECTIONABLE ARE GIVEN OFF BY ANAEROBIC DECOMPOSITION AND ARE ADSORBED AND/OR BROKEN DOWN BY AEROBIC ORGANISMS BEFORE THEY ESCAPE TO THE AIR.

C-4 SYMBIOTIC CYCLE

THE STABILIZATION OF WASTEWATER IN A POND IS ACCOMPLISHED BY A COMPLEX COMMUNITY OF MICRO-ORGANISMS. THE PHENOMENON OF STABILIZATION IS A MUTUALLY BENEFICIAL INTERACTION OR SYMBIOTIC RELATIONSHIP BETWEEN BACTERIA AND ALGAE, WHICH IN PROPER COMBINATION CAUSE THE OBJECTIONABLE CHARACTERISTICS OF WASTEWATER TO DISAPPEAR. THIS MUTUALLY BENEFICIAL INTERACTION IS CALLED THE SYMBIOTIC CYCLE.

ALTHOUGH CHEMOHETEROTROPHIC BACTERIA ARE LARGELY RESPONSIBLE FOR THE BIOLOGICAL OXIDATION OF WASTEWATER IN STABILIZATION PONDS, JUST AS THEY ARE IN TRICKLING FILTERS OR ACTIVATED SLUDGE AERATION TANKS, MANY OTHER MICRO-ORGANISMS ALSO PLAY VITAL ROLES IN POND OPERATION. THESE BACTERIA AND OTHER ORGANISMS OBTAIN THEIR ENERGY BY BIOLOGICAL OXIDATION OF ORGANIC MATTER, USING MOLECULAR OXYGEN AS THE OXIDIZING AGENT. IN THE PROCESS OF BIOLOGICAL OXIDATION, ORGANIC COMPOUNDS ARE PARTIALLY OR COMPLETELY OXIDIZED TO CARBON DIOXIDE AND WATER. OBVIOUSLY, THIS PROCESS REQUIRES THE PRESENCE OF OXYGEN IN THE DISSOLVED FORM SINCE OXIDATION CAN OCCUR ONLY UNDER AEROBIC CONDITIONS. THE UTILIZATION OF MOLECULAR OXYGEN BY BACTERIA AND OTHER MICRO-ORGANISMS MAY BE CALLED AEROBIC RESPIRATION AND THE ROLE OF THESE ORGANISMS IN THE ECOLOGY OF THE POND IS SIMILAR TO THAT OF OXYGEN-BREATHING ANIMALS IN THE TOTAL BALANCE OF ANIMALS AND PLANT IN NATURE.

THE BREAKDOWN OF COMPLEX ORGANIC COMPOUNDS SUCH AS THE

CARBOHYDRATES, FATS, AND PROTEINS BY AEROBIC BACTERIA PRODUCES SIMPLER INORGANIC SUBSTANCE SUCH AS CARBON DIOXIDE (CO_2), AMMONIA (NH_3), NITRATES (NO_3^-), NITRITES (NO_2^-), PHOSPHATES (PO_4^-) AND OTHER NUTRIENTS REQUIRED BY ALGAE FOR VARIOUS LIFE PROCESSES. THROUGH PHOTOSYNTHESIS, ALGAE LIBERATE EXCESS OXYGEN WHICH HELPS TO MAINTAIN THE AEROBIC SYSTEM. ALGAE ARE MICROSCOPIC PLANTS WHICH ARE SWIMMING OR FLOATING, UNICELLULAR OR COLONIAL ORGANISMS, ALSO KNOWN AS PHYTOPLANKTON. THESE ORGANISMS, ALTHOUGH EXCEEDINGLY SMALL, OFTEN FORM MASSES OR COLONIES IN SUFFICIENT QUANTITY TO GIVE THE PONDS A GREEN COLOR.

A SMALL PORTION OF THE TOTAL PHOTOSYNTHESIS OF A STABILIZATION POND IS ATTRIBUTABLE TO FILAMENTOUS ORGANISMS ATTACHED TO THE MUD, SLUDGE AND OTHER DEBRIS ON THE POND BOTTOM. THESE ATTACHED FILAMENTOUS ORGANISMS, KNOWN AS PHOTOBENTHOS, ARE ALSO GENERALLY CLASSIFIED AS ALGAE, ALTHOUGH SOME AUTHORITIES MAY CONSIDER THE FLAGELLATED GREEN PLANKTONIC FORMS AS PROTOZOA.

THE OVERALL PROCESS OF STABILIZATION CAUSES A CONVERSION OF MOST OF THE RELATIVELY UNSTABLE ORGANIC MATTER IN WASTEWATER TO A MORE STABLE ALGAL MASS. MOST OF THE SEWAGE SOLIDS IN THE FORM OF SLUDGE, BACTERIAL MASS AND ALGAL MASS EVENTUALLY ACCUMULATE ON THE BOTTOM OF THE PRIMARY AND SECONDARY PONDS IN THE FORM OF A THIN GELATINOUS LAYER OF MUD OR SLUDGE. (THROUGH THE PROCESS OF ANAEROBIC DECOMPOSITION, THIS SLUDGE LAYER WILL BE DECOMPOSED AND IN MOST CASES, WILL NOT CAUSE ANY PROBLEMS OVER THE DESIGN LIFE OF THE SYSTEM.) THE PROCESS OF CONVERTING

SEWAGE AND OTHER WASTES INTO ALGAL CELLS MAY SOME DAY BE USED BY MAN IN ECONOMICAL PRODUCTION OF FOOD FOR HIMSELF AND DOMESTIC ANIMALS.

THE SYMBIOTIC CYCLE OF BACTERIA AND ALGAE IS SHOWN SCHEMATICALLY IN THE ILLUSTRATION IN FIGURE 8. *FIGURES* 9 *AND* 10 *SHOW SOME TYPICAL ALGAE FOUND IN STABILIZATION PONDS.*

FIGURE 11 *ILLUSTRATES BACTERIA.*

C-5 EFFECTS OF WIND ACTION

THE ADSORPTION OF ATMOSPHERIC OXYGEN AT THE SURFACE OF A POND CAN BE IMPORTANT WHEN RELATED TO THE TOTAL OXYGEN SUPPLIED FOR BIOMASS RESPIRATION ONLY UNDER CERTAIN CONDITIONS:

1. THE AMOUNT OF OXYGEN ADDED ON A DAY TO DAY BASIS IS QUITE SMALL; HOWEVER, WHEN RELATED TO LONG DETENTION TIMES, IT MAY ACCOUNT FOR A CONSIDERABLE AMOUNT.
2. WHEN THE DISSOLVED OXYGEN CONCENTRATION IS LESS THAN SATURATION AT A GIVEN WATER TEMPERATURE MORE OXYGEN MAY BE ADSORBED AT THE WATER-AIR INTERFACE.
3. IF THE SURFACE OF THE POND IS AGITATED BY WIND ACTION THE WATER CAN MORE EASILY TAKE UP OXYGEN.

NORMALLY, STABILIZATION PONDS ARE NOT AS SUBJECT TO WAVE ACTION AS ARE ADJACENT NATURAL LAKES. THIS CAN BE ATTRIBUTED TO THE LOWER SURFACE TENSION CAUSED BY DETERGENTS IN THE WASTEWATER. DURING PERIODS OF SUPER-SATURATION OF OXYGEN IN THE PONDS CAUSED BY RAPID ALGAL PHOTOSYNTHESIS, THE GASEOUS EX-

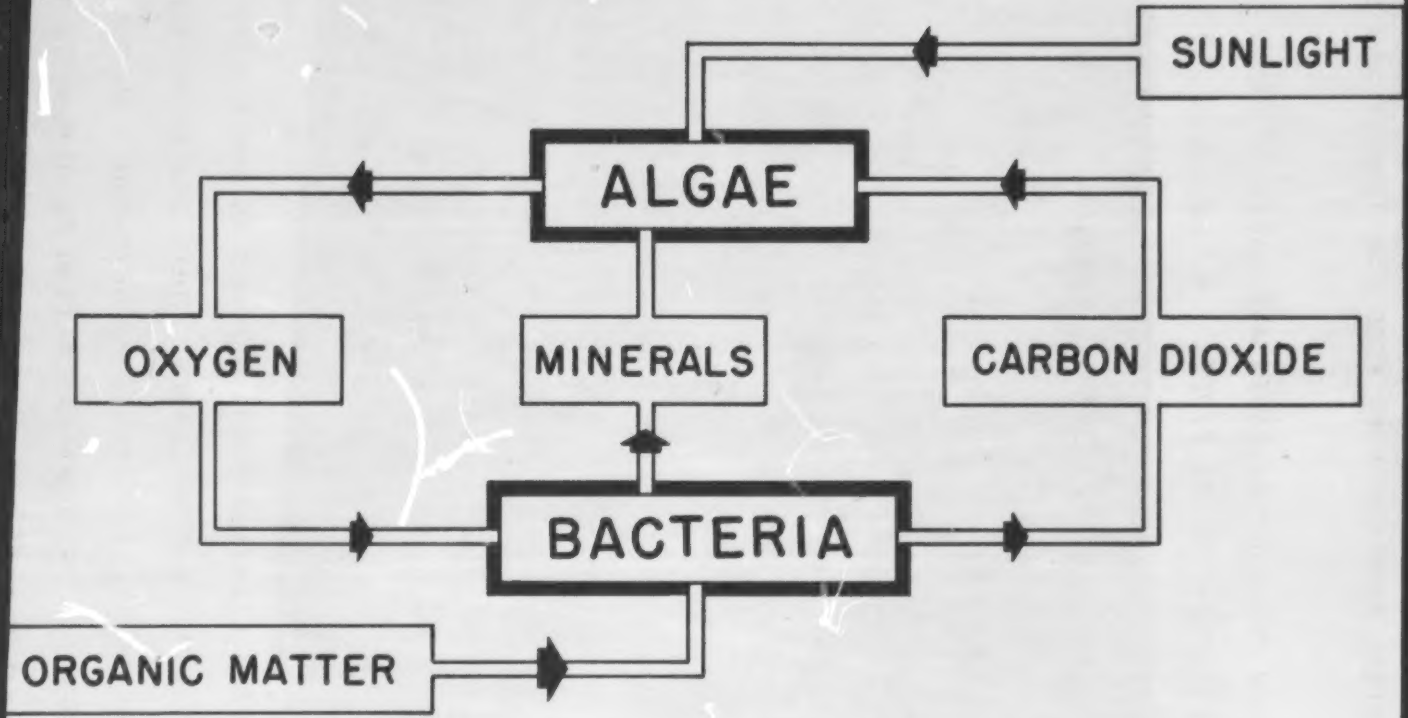
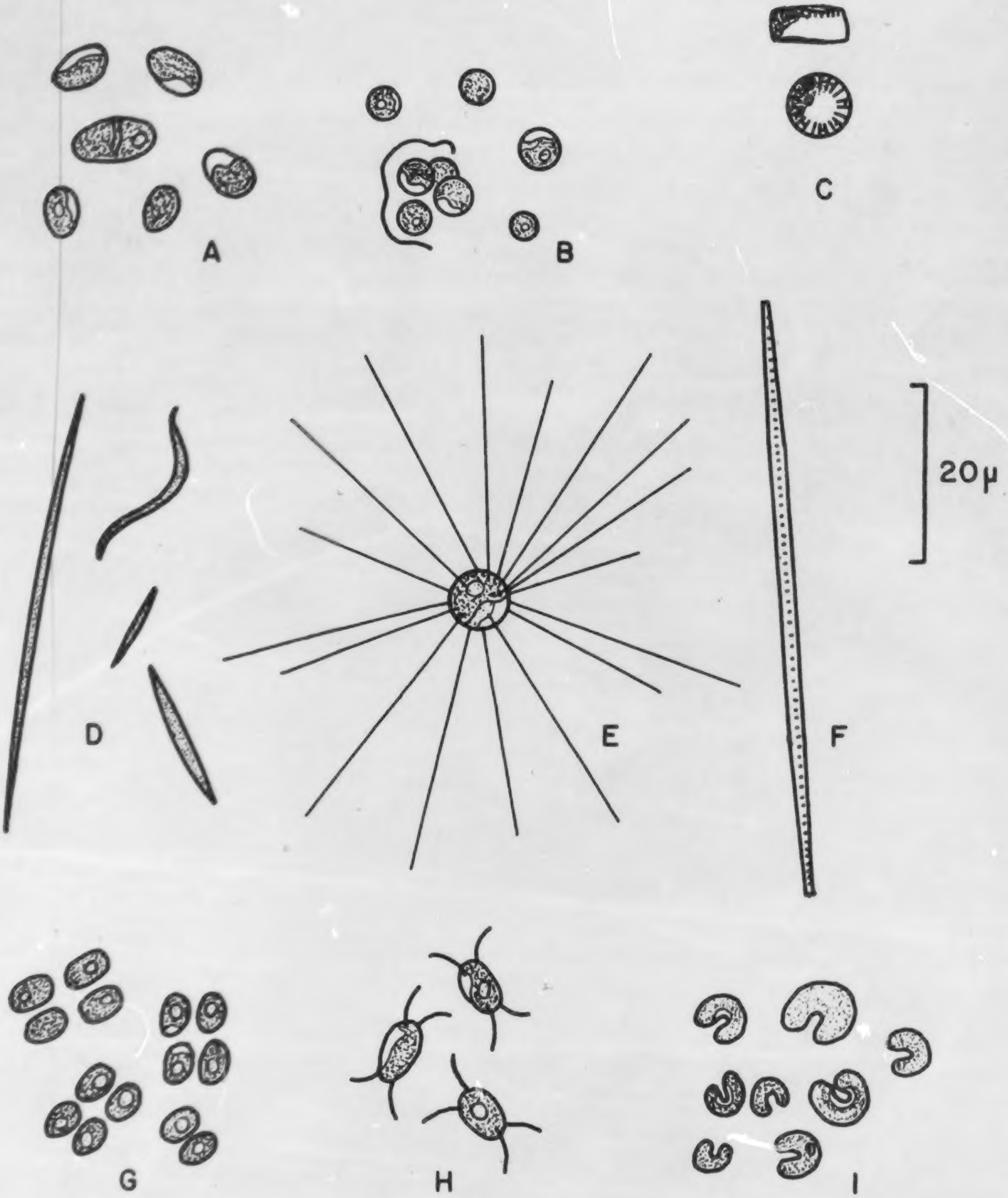

SUNLIGHT
ALGAE
OXYGEN
MINERALS
CARBON DIOXIDE
BACTERIA
ORGANIC MATTER

DIAGRAM OF POND ACTIVITY
SYMBIOTIC CYCLE

Figu[illegible] 8

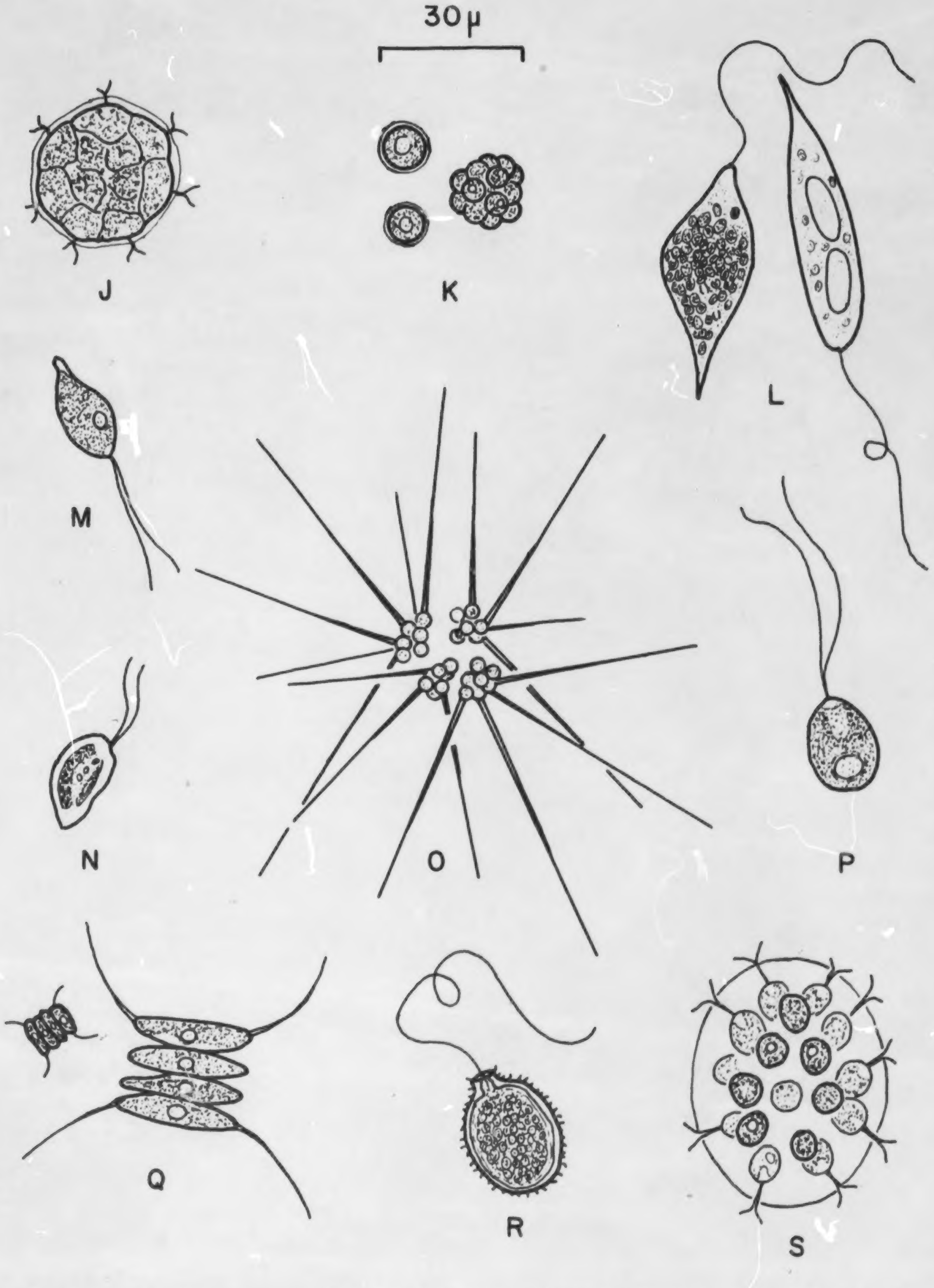
STABILIZATION POND ALGAE



A. Chlorella ellipsoidea. B. Chlorella vulgaris. C. Cyclotella operculata.
D. Ankistrodesmus spp. E. Golenkinia radiata F. Nitzschia palea.
G. Crucigenia rectangularis H. Chodatella quadriseta I. Selenostrum minutum.

FIGURE 9

STABILIZATION POND ALGAE



J. Pandorina morum. K. Coelastrum microporum L. Euglena spp.
M. Chlorogonium euchlorum. N. Cyptomonas erosa. O. Micractinium pusillum
P. Chlamydomonas sp. Q. Scenedesmus spp. R. Trachelomonas sp.
S. Eudorina elegans

FIGURE 10

TYPES OF BACTERIA

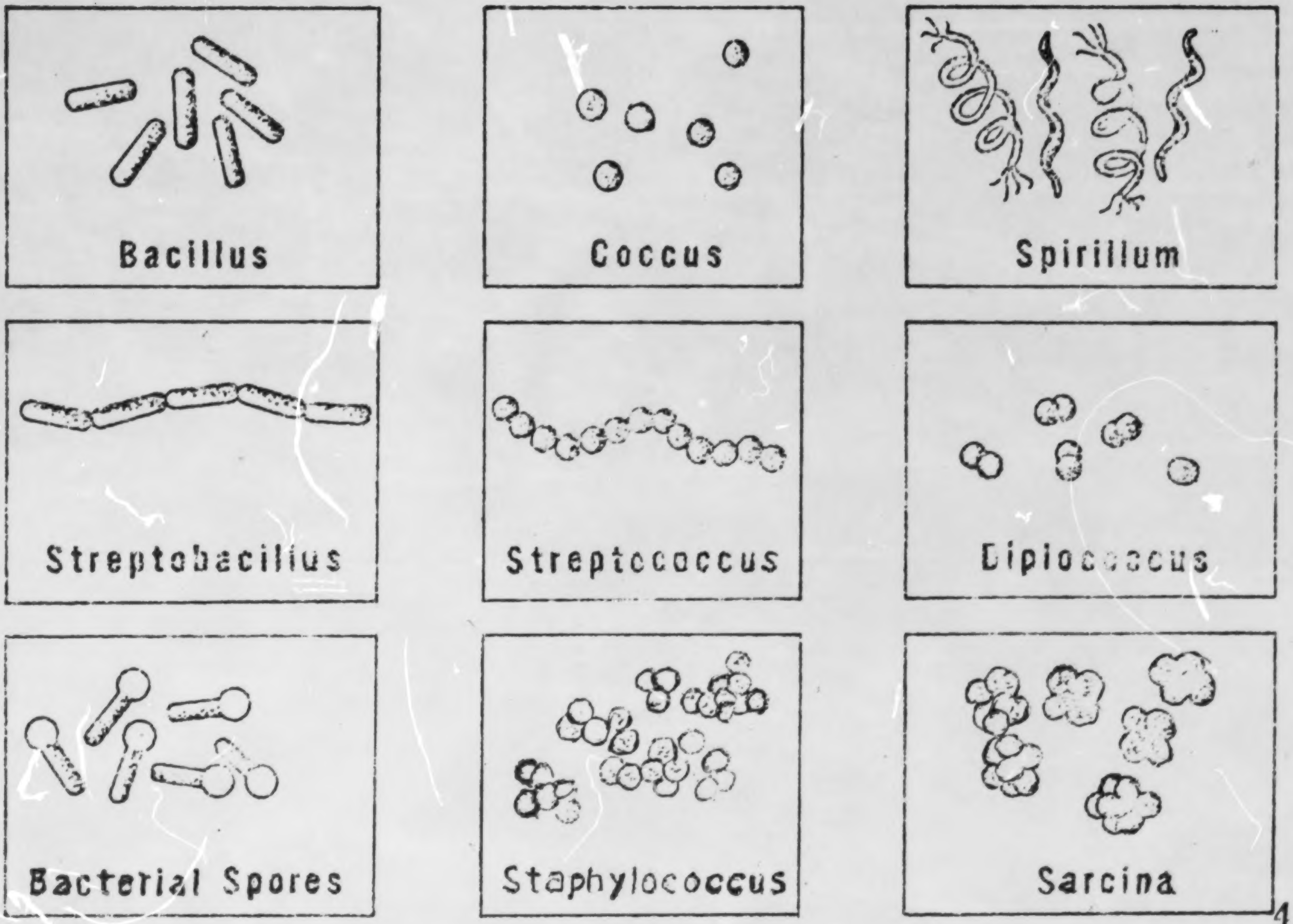

Bacillus
Coccus
Spirillum
Streptobacillus
Streptococcus
Diplococcus
Bacterial Spores
Staphylococcus
Sarcina

FIGURE 11

CHANGE AT THE SURFACE OF THE POND RESULTS IN LOSS OF OXYGEN TO THE ATMOSPHERE BY DE-AERATION FROM WIND ACTION.

C-6 INFLUENCE OF LIGHT

BECAUSE OF THE ROLE OF PHOTOSYNTHESIS IN PRODUCTION OF OXYGEN, LIGHT IS INDISPENSABLE TO THE STABILIZATION PROCESS. THREE DIFFERENT BUT RELATED CONSIDERATIONS ARE INVOLVED IN THE IMPORTANCE OF LIGHT WHICH HELP TO DETERMINE HOW WELL THE POND OPERATES AND THE AREA AND DEPTH NEEDED FOR PROPER OPERATION.

A. THERE IS A REGIONAL VARIATION IN THE ANNUAL SOLAR RADIATION WHICH IS GOVERNED BY LATITUDE, ELEVATION, AND CLOUD COVER. FOR MOST OF MINNESOTA, THE NORMAL ANNUAL SUNSHINE IS ABOUT 50 TO 60 PERCENT OF THE TOTAL POSSIBLE.

B. MORE IMPORTANT IN MINNESOTA, IS THE SEASONAL CHANGE IN THE AMOUNT OF DAILY SOLAR RADIATION. NORMAL SUMMER SUNSHINE IS ABOUT 70 PERCENT AND NORMAL WINTER SUNSHINE ABOUT 40 TO 50 PERCENT OF THE TOTAL POSSIBLE.

C. THE DEPTH WHICH LIGHT PENETRATES THE LIQUID IN THE POND. THE DEPTH OF PENETRATION WILL DETERMINE THE EXTENT TO WHICH THE POND VOLUME PARTICIPATES IN OXYGEN PRODUCTION AND HENCE THE DESIGN OF OPTIMUM POND OPERATING DEPTH. SURFACE LOSSES OF LIGHT BY REFLECTION INCREASE WITH SURFACE ROUGHENING BY WIND BUT ARE GENERALLY FOUND TO BE ABOUT 30 PERCENT OF THE

INCIDENT LIGHT. VARIATIONS IN LIGHT INTENSITY WITH DEPTH ARE LARGELY DETERMINED BY ALGAL DENSITY, WHICH VARIES SEASONALLY AND FROM POND TO POND. ONE STUDY ON LIGHT PENETRATION SHOWED THAT 99 PERCENT OF INCIDENT LIGHT IN A NEARBY ARTIFICIAL LAKE WAS ABOUT 21 FEET. IT WAS ALSO FOUND THAT OXYGEN PRODUCTION DID NOT EQUAL OXYGEN DEMAND AT DEPTHS GREATER THAN 24 INCHES WITHOUT VERTICAL MIXING BY THE WIND. AN OPERATING DEPTH BETWEEN ONE AND FIVE FEET IS RECOMMENDED FOR OPTIMUM UTILIZATION OF LIGHT AND FOR CONTROL OF BOTTOM-ROOTED AQUATIC VEGETATION. HOWEVER, WHEN WATER DEPTHS ARE LESS THAN THREE FEET, AQUATIC VEGETATION MAY OCCUR; THEREFORE CLOSE CONTROL OF THE POND DEPTH IS NECESSARY.

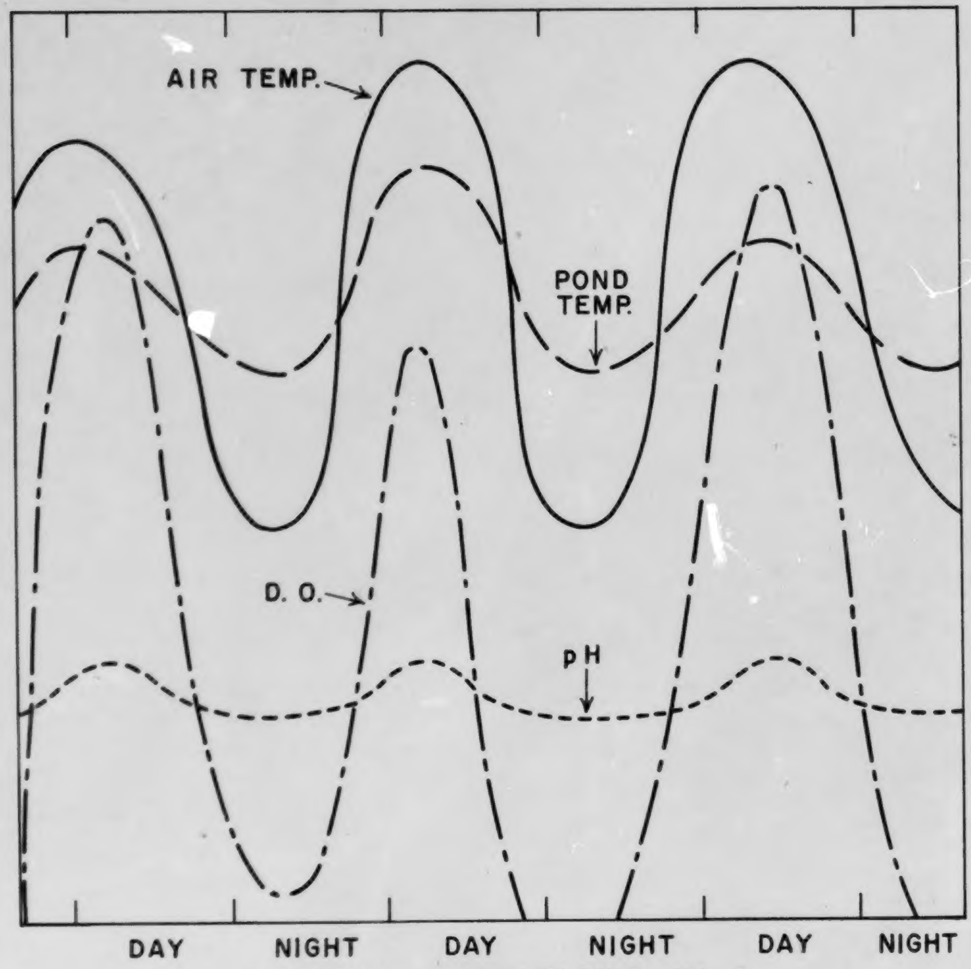
C-7 INFLUENCE OF TEMPERATURE

TEMPERATURE OF THE POND AS RELATED TO SEASONAL CHANGES IN WEATHER AFFECTS THE STABILIZATION PROCESS MAINLY THROUGH THE INFLUENCE ON THE RATE OF THE BIOCHEMICAL OXYGEN DEMAND (BOD) REACTION, THE SPECIES AND DENSITY OF ALGAE, BACTERIAL ACTIVITY, ALGAL RESPIRATION AND THE DISSOLVED OXYGEN SATURATION VALUE. GENERALLY, THE RATE OF THE BOD REACTION, DENSITY OF ALGAE, BACTERIAL ACTIVITY AND ALGAL RESPIRATION RATE DECREASE WITH DECREASING TEMPERATURES. ON THE OTHER HAND, THE DISSOLVED OXYGEN SATURATION VALUE INCREASES WITH DECREASING TEMPERATURE. FOR EXAMPLE, JUST BEFORE AND AFTER ICE COVER, THE D.O.

HOLDING CAPACITY OF WATER MAY BE ALMOST TWICE THE SUMMERTIME VALUE. AS LONG AS ICE IS NOT A BARRIER, SURFACE ABSORPTION OF OXYGEN ASSUMES GREATER IMPORTANCE AS A MECHANISM FOR OXYGEN UPTAKE AND GREATLY HELPS SATISFY THE OXYGEN DEMANDS EXERTED DURING COLD WEATHER.

C-8 DIURNAL FLUCTUATIONS

CHANGES IN SOLAR RADIATION AND AIR TEMPERATURES OVER A 24 HOUR PERIOD CAUSE DIURNAL VARIATIONS IN POND TEMPERATURE, DISSOLVED OXYGEN CONCENTRATION, PH, AND OTHER CHARACTERISTICS. DAILY HIGHS IN DISSOLVED OXYGEN MAY BE 300 PERCENT OF SATURATION, WHILE NIGHTTIME LOWS MAY APPROACH OR REACH ZERO. DIURNAL FLUCTUATIONS OF PH, REACHING AS HIGH AS 10 IN THE DAYTIME, ARE RELATED TO THE UTILIZATION OF CARBON DIOXIDE IN THE PROCESS OF PHOTOSYNTHESIS. ALTHOUGH ALGAE MAY USE FREE CARBON DIOXIDE, IT IS MORE LIKELY THAT THE BULK OF REQUIRED CARBON DIOXIDE IS OBTAINED BY THE BREAKING DOWN OF BIOCARBONATES RESULTING IN THE FORMATION OF MONOCARBONATES WHICH PRODUCE HIGHER PH VALUES.



DIURNAL VARIATIONS IN A STABILIZATION POND

FIGURE 12

C-9 WINTER CONDITIONS

MOST OF THE PRECEDING DISCUSSION DESCRIBES THE INTERACTION WHICH TAKES PLACE UNDER AEROBIC OR OPEN WATER CONDITIONS. IN THE WINTER, UNDER ICE AND SNOW COVER, THE SUNLIGHT AND ABSORPTION OF OXYGEN FROM THE ATMOSPHERE IS SHUT OFF. THEREFORE, DISSOLVED OXYGEN IS NOT AVAILABLE FOR AEROBIC DECOMPOSITION AND ANAEROBIC DECOMPOSITION OF SEWAGE SOLIDS TAKES PLACE. ANAEROBIC BIOLOGICAL ACTIVITY TAKES PLACE AT A SLOW RATE BECAUSE OF THE LOW TEMPERATURE OF THE WASTEWATER IN THE POND. DURING THE PERIOD OF COMPLETE ICE COVER, ODOROUS GASES FORMED BY ANAEROBIC

DECOMPOSITION ACCUMULATE UNDER THE ICE AND ARE CONTINUOUSLY DISSOLVED INTO THE POND WATER. SOME ODORS MAY BE OBSERVED IN THE SPRING JUST AFTER THE ICE COVER BREAKS UP BECAUSE THE POND IS STILL IN THE ANAEROBIC STATE AND SOME OF THESE DISSOLVED GASES NATURALLY WENT INTO THE ATMOSPHERE. MELTING OF ICE IN THE SPRING FURNISHES OXYGEN-RICH DILUTION WATER AND THE TRANSITION FROM ANAEROBIC TO AEROBIC CONDITIONS AFTER BREAKUP OF ICE GENERALLY OCCURS IN A MATTER OF A FEW DAYS PROVIDED THE PONDS ARE NOT ORGANICALLY OVERLOADED.

FIGURE 13 *SHOWS THE SEASONAL VARIATIONS OF BIOLOGICAL ACTIVITIES WHICH OCCUR IN THE STABILIZATION POND PROCESS.*

ADDITIONAL SOURCES OF INFORMATION

SACRAMENTO STATE HOME-STUDY COURSE, CHAPTER 9

TEXAS MANUAL, CHAPTER 16

SEASONAL VARIATIONS OF BIOLOGICAL ACTIVITY STABILIZATION PONDS

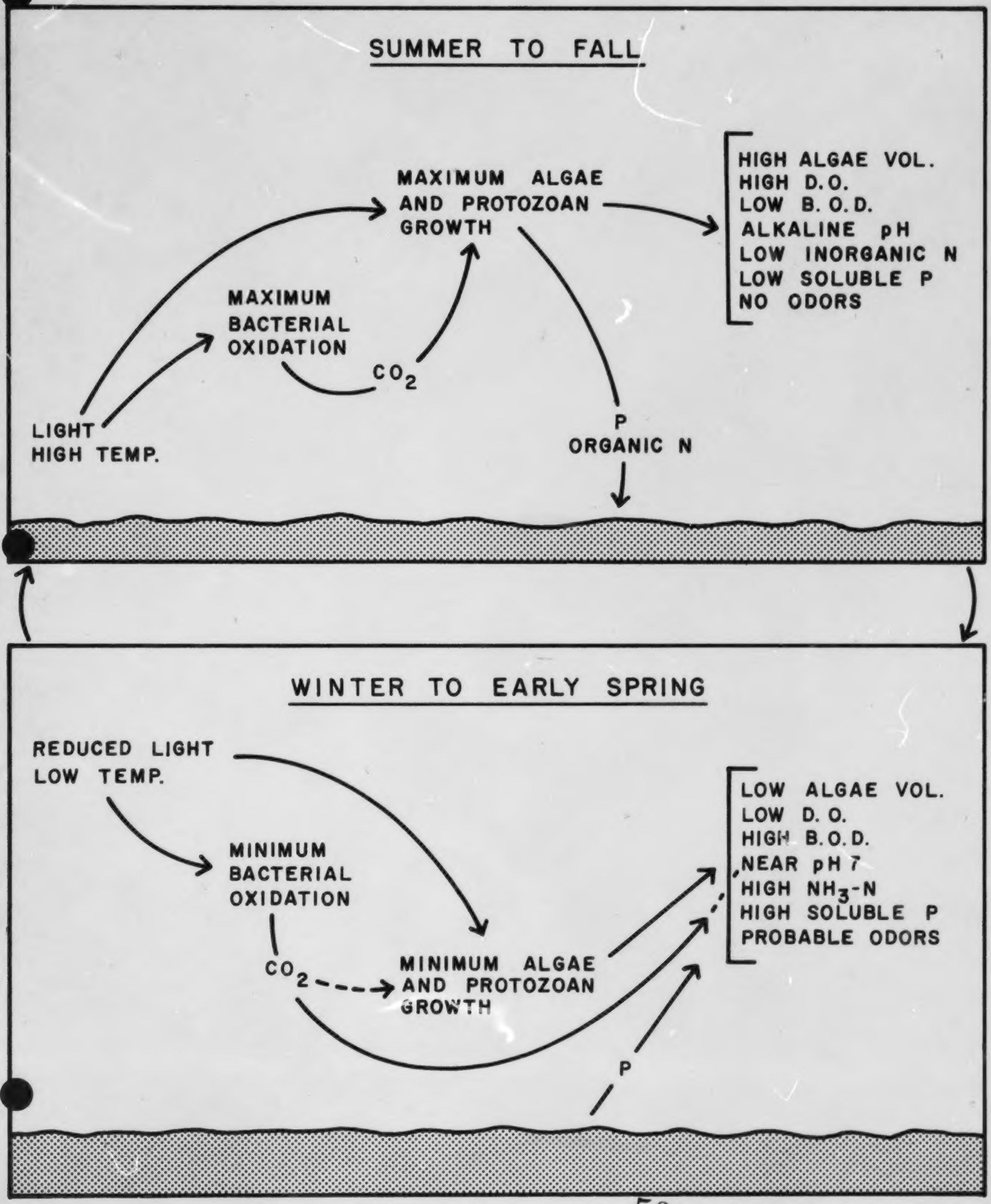

SUMMER TO FALL
MAXIMUM ALGAE AND PROTOZOAN GROWTH
HIGH ALGAE VOL.
HIGH D.O.
LOW B.O.D.
ALKALINE pH
LOW INORGANIC N
LOW SOLUBLE P
NO ODORS
MAXIMUM BACTERIAL OXIDATION
CO$_2$
LIGHT
HIGH TEMP.
P
ORGANIC N
WINTER TO EARLY SPRING
REDUCED LIGHT
LOW TEMP.
LOW ALGAE VOL.
LOW D.O.
HIGH B.O.D.
NEAR pH 7
HIGH NH$_3$-N
HIGH SOLUBLE P
PROBABLE ODORS
MINIMUM BACTERIAL OXIDATION
CO$_2$
MINIMUM ALGAE AND PROTOZOAN GROWTH
P

Figure 13

SECTION D

STABILIZATION POND

DESIGN CRITERIA

D-1 GENERAL

DESIGN CRITERIA FOR WASTE STABILIZATION PONDS VARY, DEPENDING ON EXPERIENCE IN THE VARIOUS AREAS. THERE ARE MANY FACTORS AFFECTING POND OPERATION, SUCH AS TOTAL AREA, LOADING, DEPTH, STORAGE CAPACITY, AND CLIMATIC CONDITIONS. PROBABLY THE MOST IMPORTANT FACTORS AFFECTING DESIGN OF THE PONDS ARE THE LOADING AND CLIMATIC CONDITIONS FOR THE AREA. THE CLIMATIC CONDITIONS IN MINNESOTA DICTATE THAT THE LOADING BE LESS THAN FOR AREAS FURTHER SOUTH AND WEST.

THE GREAT LAKES UPPER MISSISSIPPI RIVER BOARD OF STATE SANITARY ENGINEERS HAVE PUBLISHED A TEXT ENTITLED "RECOMMENDED STANDARDS FOR SEWAGE WORKS" WHICH INCLUDES DESIGN STANDARDS FOR WASTE STABILIZATION PONDS. THE STANDARDS ARE USED AS A GUIDE FOR ENGINEERS IN THE DESIGN OF PONDS AND ARE USED BY THE MINNESOTA POLLUTION CONTROL AGENCY IN REVIEW OF PLANS AND SPECIFICATIONS FOR THESE PROJECTS.

THE FOLLOWING DISCUSSION INCLUDES SOME OF THE MORE IMPORTANT ITEMS WHICH ARE CONSIDERED IN THE DESIGN OF WASTE STABILIZATION PONDS.

D-2 AREA AND LOADINGS OF THE PRIMARY CELL

GENERALLY, ONE ACRE OF WATER SURFACE IS PROVIDED FOR EACH 100-120 DESIGN POPULATION OR POPULATION EQUIVALENT. IN TERMS OF BOD, A LOADING OF APPROXIMATELY 20 POUNDS PER DAY PER ACRE SURFACE AREA SHOULD NOT BE EXCEEDED. HIGHER DESIGN LOADINGS WILL BE JUDGED AFTER REVIEW OF MATERIAL CONTAINED IN THE ENGINEER'S REPORT AND AFTER A FIELD INVESTIGATION OF THE PROPOSED SITE BY A REPRESENTATIVE OF THE AGENCY.

D-3 STORAGE CAPACITY

THE STORAGE CAPACITY IN THE PONDS IS DETERMINED BY BOTH THE AVERAGE SURFACE AREA AND MAXIMUM OPERATING DEPTH. SINCE TREATMENT EFFICIENCY OF THE PONDS IS GREATLY REDUCED DURING THE PERIOD OF ICE COVER, WHICH IS ABOUT 6 MONTHS IN MINNESOTA, THE PONDS ARE DESIGNED WITH SUFFICIENT CAPACITY TO STORE THE ENTIRE SEWAGE FLOW FOR THIS PERIOD. THIS STORAGE CAPACITY IS CALCULATED TO INCLUDE THAT VOLUME BETWEEN THE ONE-FOOT LIQUID LEVEL AND THE MAXIMUM LIQUID LEVEL NOT TO EXCEED 5 FEET IN THE PRIMARY AND SECONDARY CELLS. THE POND DIKES ARE DESIGNED FOR 3 FEET OF FREEBOARD ABOVE THE MAXIMUM LIQUID LEVEL WITH A FAIRLY GENTLE SLOPE ON THE INSIDE TO MINIMIZE EROSION AT THE WATER LINE.

D-4 MULTIPLE UNITS

STABILIZATION PONDS ARE DESIGNED WITH BOTH A PRIMARY CELL(S) AND A SECONDARY CELL. IF THE SIZE OF THE PRIMARY CELL(S)

IS UNUSUALLY LARGE FOR THE SIZE OF THE COMMUNITY BECAUSE OF HIGH STRENGTH INDUSTRIAL WASTE INVOLVED, THE PRIMARY CELL SHOULD BE DIVIDED IN TWO AND ARRANGED FOR BOTH SERIES AND PARALLEL OPERATION TO PERMIT FLEXIBILITY OF OPERATION.

A SECONDARY CELL IS USUALLY FROM ONE-QUARTER TO ONE-HALF THE AREA OF THE PRIMARY CELL, AND IS ARRANGED TO BE OPERATED IN SERIES WITH THE PRIMARY CELL. SECONDARY CELLS HAVE BEEN DEMONSTRATED TO BE OF PARTICULAR VALUE IN REDUCING THE CARRY OVER OF ALGAE AND SEWAGE NUTRIENTS AND ALSO IN PROVIDING FURTHER REDUCTION IN WASTEWATER BACTERIAL COUNTS.

D-5 LOCATION

AS MUCH CONSIDERATION SHOULD BE GIVEN IN THE LOCATION OF STABILIZATION PONDS AS IS GIVEN TO THE LOCATION OF CONVENTIONAL SEWAGE TREATMENT PLANTS. MUCH OF THE OBJECTION TO THE LOCATION OF A SEWAGE TREATMENT FACILITY, AND PARTICULARLY STABILIZATION PONDS, IS BASED ON AESTHETIC CONSIDERATION. JUST AS IN THE CASE OF CONVENTIONAL PLANTS, STABILIZATION PONDS MAY DEVELOP ODOR NUISANCE CONDITIONS WHEN SOME PORTION OF THE PROCESS IS OUT OF BALANCE. NORMALLY THE WINTER TO SPRING TRANSITION WILL BE THE ONLY PERIOD OF ANY NOTICEABLE ODOR. THE DURATION OF THIS PERIOD IS GENERALLY LESS THAN A WEEK, HOWEVER, IT MAY BE LONGER WHEN LOADINGS ARE HEAVIER THAN PROVIDED FOR IN THE DESIGN. STABILIZATION PONDS, LIKE OTHER WASTEWATER TREATMENT FACILITIES, SHOULD BE LOCATED AS FAR FROM EXISTING AND FUTURE RESIDENTIAL AND COMMERCIAL DEVELOPMENT AS IS REASONABLY PRACTICABLE AND

ECONOMICALLY FEASIBLE. IN MINNESOTA, IT IS RECOMMENDED THAT THEY BE AT LEAST ONE-HALF MILE FROM THE EXISTING OR FUTURE RESIDENTIAL AND COMMERCIAL DEVELOPMENTS IN THE MUNICIPALITY AND AT LEAST ONE-QUARTER MILE FROM EXISTING RURAL OR ISOLATED HOMES.

D-6 SOIL CONDITIONS

THE SOIL AT THE SITE IS IMPORTANT IN DETERMINING THE ECONOMIC FEASIBILITY OF PONDS. IF THE SOIL NATIVE TO THE SITE IS NOT A FAIRLY IMPERVIOUS CLAY, CLAY MATERIAL OR OTHER SUITABLE SEAL MATERIAL MAY HAVE TO BE USED TO CONSTRUCT THE DIKES AND LINE THE POND BOTTOM. LOCATION OF STABILIZATION PONDS IN AREAS WHERE FISSURED ROCK FORMATIONS ARE NEAR THE SURFACE OF THE GROUND SHOULD NOT BE ATTEMPTED.

THE POND BOTTOM SHOULD BE CLEARED OF VEGETATION AND DEBRIS. IT IS ADVISABLE TO STERILIZE THE SOIL OF ALL CELLS WHICH WILL REMAIN DRY FOR ANY EXTENDED PERIOD OF TIME. STERILANTS CONTAINING SODIUM CHLORATE OR SODIUM BORATE OR BOTH, ARE COMMONLY USED; HOWEVER, MANY OTHER ORGANIC CHEMICALS ARE AVAILABLE AND WE SUGGEST THAT INFORMATION ON SOIL STERILANTS BE OBTAINED FROM A RELIABLE CHEMICAL COMPANY.

THE BOTTOM OF THE POND SHOULD BE AS LEVEL AS POSSIBLE AT ALL POINTS TO AVOID SHALLOW AREAS RESULTING IN LOCALLY UNSATISFACTORY CONDITIONS. VEGETATION CONTROL WITHIN THE PONDS WILL BE EXPANDED ON IN SECTION F OF THIS MANUAL.

D-7 FENCING AND SIGNS

THE POND AREA SHALL BE ENCLOSED WITH A SUITABLE FENCE TO PRECLUDE LIVESTOCK AND DISCOURAGE TRESPASSING. A VEHICLE ACCESS GATE OF SUFFICIENT WIDTH TO ACCOMODATE MOWING EQUIPMENT SHOULD BE PROVIDED. ALL ACCESS GATES SHOULD BE PROVIDED WITH LOCKS.

APPROPRIATE SIGNS SHOULD BE PROVIDED ALONG THE FENCE AROUND THE POND TO DESIGNATE THE NATURE OF THE FACILITY AND FORBID TRESPASSING. THE SIGNS SHOULD BE POSTED NOT MORE THAN 500 FEET APART.

ADDITIONAL SOURCES OF INFORMATION:

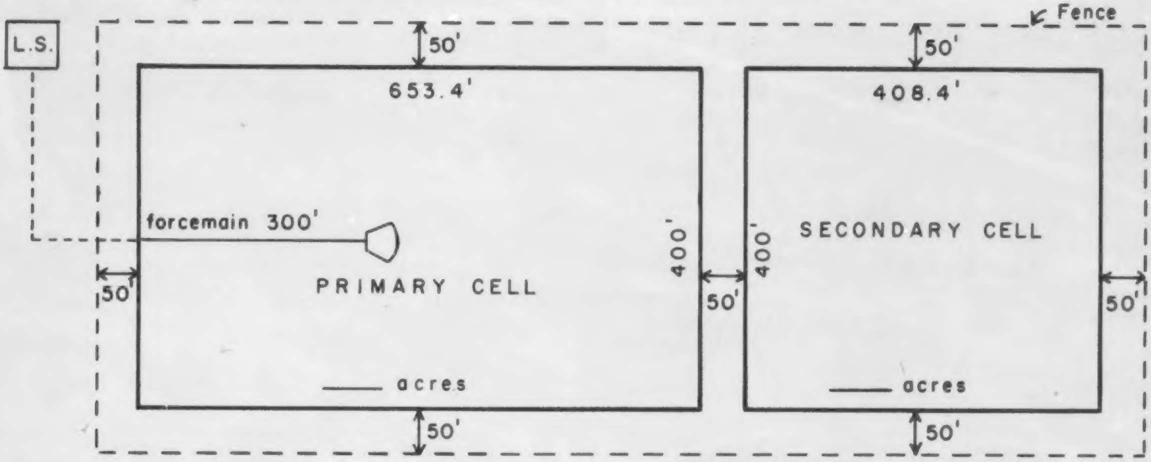
SACRAMENTO STATE HOME-STUDY COURSE, CHAPTER 9

TEN STATE STANDARDS FOR SEWAGE WORKS

TEXAS MANUAL, CHAPTER 16

D-8 DESIGN PARAMETER CALCULATION PROBLEM:

SUDSVILLE MINNESOTA STABILIZATION PONDS


L.S.
Fence
50'
50'
653.4'
408.4'
forcemain 300'
400'
400'
SECONDARY CELL
PRIMARY CELL
50'
50'
50'
___ acres
___ acres
50'
50'

DESIGN LOADING

ORGANIC LOAD = 120 POUNDS BOD$_5$ PER DAY @ 0.17 POUNDS PER PERSON PER DAY.

20 LBS. PER ACRE OF PRIMARY CELL AT MEDIAN DEPTH OF THREE FEET.

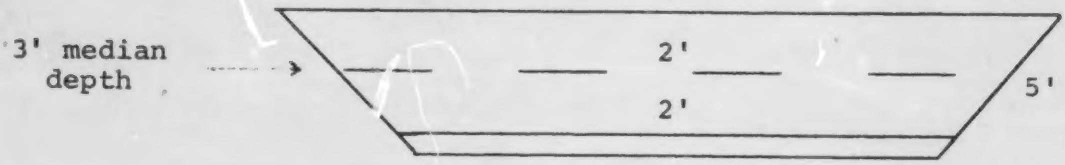
HYDRAULIC LOAD = 100 GALLONS PER CAPITA PER DAY.

NO INFILTRATION TAKEN INTO ACCOUNT.

DESIGN STORAGE

PRIMARY CELL = STORAGE CALCULATED BETWEEN ONE FOOT AND FIVE FOOT LEVEL.

SECONDARY CELL = STORAGE CALCULATED BETWEEN ONE FOOT AND FIVE FOOT LEVEL. 180 DAYS STORAGE CAPACITY.



PONDS ARE DESIGNED TO UTILIZE ONLY THE TOP FOUR FEET FOR STORAGE. THE BOTTOM 1 FOOT IS ALLOCATED FOR SEDIMENT. MEDIAN DEPTH IS ½ THE DEPTH OF THE WATER CONSIDERED FOR STORAGE. 3 FEET FROM THE BOTTOM OR TWO FEET FROM THE TOP.

1. A. WHAT IS THE SURFACE AREA OF THE PRIMARY POND AT MEDIAN DEPTH? (ANSWER IN SQUARE FEET)

   B. HOW MANY ACRES DOES THE PRIMARY POND COVER?

2. A. WHAT IS THE SURFACE AREA OF THE SECONDARY POND AT MEDIAN DEPTH? (ANSWER IN SQUARE FEET)

   B. HOW MANY ACRES DOES THE SECONDARY POND COVER?

3. THE PRIMARY POND WAS DESIGNED WITH A BOD LOADING OF 20 POUNDS PER ACRE SURFACE AREA AT MEDIAN DEPTH. IF EACH PERSON CONTRIBUTES 0.17 POUNDS BOD PER DAY, WHAT IS THE DESIGN POPULATION THIS POND COULD HANDLE AT MAXIMUM DESIGN LOAD?

4. IF PONDS ARE DESIGNED WITH A HYDRAULIC LOAD OF 100 GALLONS PER PERSON PER DAY, WHAT SOULD BE THE DAILY FLOW TO THE POND?

5. USING FLOW PER DAY FROM PROBLEM 4, DETERMINE THE STORAGE CAPACITY NEEDED TO PROVIDE 180 DAYS STORAGE.

6. USING THE SURFACE AREA FROM PROBLEM 1.A., WHAT IS THE VOLUME IN CUBIC FEET OF THE PRIMARY POND USING ONLY THE FOUR FEET ALLOCATED FOR STORAGE?

7. WHAT IS THE VOLUME AS COMPUTED IN PROBLEM 6 IN TERMS OF GALLONS?

8. USING SURFACE AREA FROM PROBLEM 2, WHAT IS THE VOLUME IN CUBIC FEET OF THE SECONDARY POND THAT IS AVAILABLE FOR STORAGE?

9. WHAT IS THE VOLUME AS COMPUTED IN PROBLEM 8, IN TERMS OF GALLONS?

10. A. WHAT IS THE TOTAL STORAGE CAPACITY OF BOTH PONDS AS COMPUTED IN PROBLEMS 7 AND 9?

B. HOW DOES THIS COMPARE TO NEEDED STORAGE CAPACITY AT DESIGN FLOWS?

SUDSVILLE, MINNESOTA
SUMMARY OF DESIGN PARAMETERS CALCULATION PROBLEM
ANSWER SHEET

1. A. PRIMARY POND AREA ______________ FT^2
   B. PRIMARY POND AREA ______________ ACRES

2. A. SECONDARY POND AREA ______________ FT^2
   B. SECONDARY POND AREA ______________ ACRES

3. DESIGN POPULATION ______________ PEOPLE

4. DESIGN DAILY FLOW ______________ GALLONS

5. HOLDING CAPACITY NEEDED ______________ GALLONS

6. PRIMARY POND STORAGE VOLUME ______________ FT^3

7. PRIMARY POND STORAGE VOLUME ______________ GALLONS

8. SECONDARY POND STORAGE VOLUME ______________ FT^3

9. SECONDARY POND STORAGE VOLUME ______________ GALLONS

10 TOTAL STORAGE CAPACITY ______________ GALLONS

ANSWERS TO DESIGN PARAMETER CALCULATION PROBLEM

1.A. 653.4 FEET X 400 FEET = 261,360 FT^2

B. $\frac{261,360\ FT^2}{43,560\ FT^2/ACRE}$ = 6 ACRES

2.A. 408.4 FEET X 400 FEET = 163,350 FT^2

B. $\frac{163,350\ FT^2}{43,560\ FT^2/ACRE}$ = 3.75 ACRES

3. 6 ACRES X 20 POUNDS/ACRE = 120 POUNDS

$\frac{120\ POUNDS}{.17\ POUNDS/PERSON}$ = 705 PEOPLE

4. 705 PEOPLE X 100 GALLONS/PERSON = 70,500 GALLONS

5. 70,500 GALLONS/DAY X 180 DAYS = 12,690,000 GALLONS

6. 261,360 FT^2 X 4 FEET = 1,045,440 FT^3

7. 1,045,400 FT^3 X 7.5 GALLONS/FT^3 = 7,840,800 GALLONS

8. 163,350 FT^2 X 4 FEET = 653,400 FT^3

9. 653,400 FT^3 X 7.5 GALLONS/FT^3 = 4,900,500 GALLONS

10.A. 7,840,800 GALLONS + 4,900,500 GALLONS = 12,741,300 GALLONS

B. 12,741,300 GALLONS - 12,690,000 = 51,300 GALLONS

THIS MEANS THERE IS 51,300 GALLONS MORE CAPACITY THAN NEEDED AT 20 YEAR DESIGN AND THEREFORE, UNLESS THERE ARE MAJOR CHANGES, THIS SYSTEM SHOULD BE MORE THAN ADEQUATE.

D-9 EXPECTED REMOVAL EFFICIENCIES

GENERAL

THE DEGREE OF TREATMENT BY WASTE STABILIZATION PONDS IN TERMS OF BACTERIAL REDUCTION, SEWAGE SOLIDS, AND BOD REDUCTION IS CONSIDERED TO BE EQUIVALENT TO THAT OBTAINED FROM MOST CONVENTIONAL SECONDARY SEWAGE TREATMENT PLANTS. RESULTS OF STABILIZATION POND TREATMENT ARE ALSO QUITE CONSISTENT SINCE CHANGES IN THE STABILIZATION PROCESS OCCUR SLOWLY WITH VIRTUALLY NO REASON FOR BY-PASSING THE PONDS FOR PERIODIC MAINTENANCE AS IS OFTEN NECESSARY IN A CONVENTIONAL MECHANICAL PLANT.

BOD REDUCTION

REDUCTIONS IN BOD CAN RANGE UP TO 98 PERCENT IN THE SUMMER AND TO A MINIMUM OF ABOUT 60 PERCENT DURING THE WINTER. IN MEASURING THE EFFICIENCY OF THE PONDS BY THE 5-DAY BOD TEST, SOME INFLUENCE MAY BE EXPECTED BY THE ALGAL CELLS IN THE SAMPLE. THE EXTENT OF THIS INFLUENCE MAY DEPEND ON THE PERCENTAGE OF DEAD OR DECOMPOSING ALGAL CELLS PRESENT IN THE SAMPLE. IN ANY CASE, THE INCUBATION OF THE SAMPLE MUST BE IN TOTAL DARKNESS OR AN ACTUAL INCREASE IN DISSOLVED OXYGEN IN THE INCUBATED SAMPLE MAY RESULT.

SOLIDS REMOVAL

IT IS DIFFICULT TO MEASURE SUSPENDED SOLIDS REMOVAL BY COMMON SUSPENDED SOLIDS TESTS USED ON RAW SEWAGE. CONDITIONS SOMETIMES OCCUR WHEREBY THE SUSPENDED SOLIDS IN THE OVERFLOW

OF A PRIMARY POND ARE GREATER THAN IN THE RAW SEWAGE BECAUSE OF THE HEAVY DENSITY OF ALGAE PRESENT. IN CASES WHERE A HIGH-DEGREE OF TREATMENT IS NECESSARY AND THERE THE HEAVY CONCENTRATION OF ALGAL CELLS IS OBJECTIONABLE, THE USE OF ONE OR MORE SECONDARY STABILIZATION PONDS IS ADVISABLE. EACH ADDITIONAL POND APPEARS TO GIVE AN ADDITIONAL REMOVAL OF ALGAE CELLS.

BACTERIOLOGICAL REDUCTION

STUDIES BY THE U. S. PUBLIC HEALTH SERVICE, AND THE STATE HEALTH DEPARTMENTS IN NORTH AND SOUTH DAKOTA AND MINNESOTA SHOW THAT BACTERIAL REDUCTION IN TERMS OF MOST PROBABLE NUMBER (MPN) OF THE COLIFORM GROUP ORGANISMS ARE IN THE ORDER OF 99 PERCENT FOR MORE THAN 50 PERCENT OF THE TIME AND MORE THAN 90 PERCENT FOR VIRTUALLY 100 PERCENT OF THE TIME, PROVIDED THE DESIGNED RETENTION TIME IS ACHIEVED. HOWEVER, THIS DOES NOT NECESSARILY MEAN THAT THE POND DISCHARGE WILL MEET THE EFFLUENT WATER QUALTIY STANDARDS.

NUTRIENT REMOVAL

ONLY LIMITED RESEARCH HAS BEEN DONE ON THE REMOVAL OF SEWAGE NUTRIENTS IN STABILIZATION PONDS; HOWEVER, FROM STUDIES THUS FAR, IT APPEARS THAT REMOVAL OF TOTAL NITROGEN AND PHOSPHORUS IS GREATER THAN IN CONVENTIONAL TREATMENT PROCESSES AND IN THE SAME ORDER AS REMOVAL OF SUSPENDED SOLIDS AND BOD. SECONDARY PONDS ASSIST CONSIDERABLY IN NUTRIENT REMOVAL.

POSSIBLE ADDITIONAL REMOVAL

IN ADDITION TO THE MICROORGANISMS WITHIN THE POND, THERE ARE LARGER OR MACROSCOPIC ORGANISMS WHICH ALSO ASSIST IN OVERALL EFFLUENT QUALITY. FOR EXAMPLE, DAPHNIA, A MACROSCOPIC ORGANISM HAS BEEN OBSERVED HARVESTING ALGAE, BACTERIA ETC., IN NUMEROUS PONDS. THE PRESENCE OF DAPHNIA GENERALLY TENDS TO IMPROVE EFFLUENT QUALITY WITH RESPECT TO SIMILAR PONDS WITHOUT DAPHNIA.

IN CALCULATING THE OVERALL REMOVAL OF SEWAGE CONSTITUENTS BY STABILIZATION PONDS, NOT ONLY THE CONCENTRATION OF THE CONSTITUENT BUT ALSO THE VOLUME OF THE POND EFFLUENT SHOULD BE TAKEN INTO ACCOUNT. IN MUCH OF MINNESOTA, THE AVERAGE EVAPORATION OF WATER FROM AN OPEN BODY OF WATER EXCEEDS THE AVERAGE PRECIPITATION BY ABOUT 5 TO 10 INCHES PER YEAR. THEREFORE, THE APPARENT PERCENT REDUCTION IN SEWAGE CONTAMINANTS, AS MEASURED BY CONCENTRATION IN MILLIGRAMS PER LITER, IS LESS THAN THE REDUCTION IN TERMS OF POUNDS, IF BASED ON VOLUMETRIC LOSSES.

THE FOLLOWING TABLE SHOWS THE REMOVAL EFFICIENCIES FROM A THREE CELL STABILIZATION POND IN MINNESOTA.

SUDSVILLE STABILIZATION PONDS

Analytical Data

	RAW SEWAGE	EFFLUENT	PERCENT REDUCTION
SUSPENDED SOLIDS*	240	10	96
TURBIDITY (JTU)	39	3.3	91
BOD*	120	2.4	98
TOTAL PHOSPHORUS*	5.7	1.2	79
SOLUBLE PHOSPHORUS*	4.1	1.1	73
AMMONIA*	14	0.10	99
ORGANIC NITROGEN*	16	2.0	88
NITRATES*	1.9	0.03	98
NITRITES*	0.05	0.05	---
pH VALVE*	7.4	9.2	---
D.O.*	---	12.4	---

*RESULTS ARE IN MILLIGRAMS PER LITER.

SECTION E

PROCESS OPERATION CONTROLS

E-1 GENERAL

STABILIZATION PONDS ARE DESIGNED TO HAVE A HOLDING CAPACITY OF APPROXIMATELY 180 DAYS. THIS CAPACITY PROVIDES THE FLEXIBILITY OF CONTROLLING THE DISCHARGE TO ONCE OR TWICE EACH YEAR, USUALLY DURING THE SPRING RUNOFF AND LATE IN THE FALL.

E-2 INITIAL FILLING

PRIOR TO THE ADDITION OF ANY WATER TO THE POND SYSTEM, MEASURES SHOULD BE TAKEN TO ENSURE THAT THE PONDS HAVE BEEN PREFILLED OR STERILIZED (IF THEY ARE TO REMAIN DRY FOR ANY PERIOD OF TIME). ONLY THE BOTTOM SHOULD BE STERILIZED, NOT THE POND DIKES. AFTER THIS, THE PONDS SHOULD ALL BE FILLED WITH A MINIMUM OF TWO FEET OF WATER THAT IS RELATIVELY LOW IN NUTRIENT VALUE. THE FOLLOWING REASONS ARE GIVEN TO ILLUSTRATE THE NEED FOR THE INITIAL FILLING.

1. AFTER FILLING TO THE TWO FOOT LEVEL, SEAL ADEQUACY SHOULD BE CHECKED TO DETERMINE IF SEAL IS ACCEPTABLE FOR OPERATION.
2. FOR PROTECTION OF THE IMPERVIOUS LINER. MOST PONDS CONSTRUCTED IN MINNESOTA ARE SEALED WITH A COMPACTED CLAY LINER. IF THIS LINER IS PERMITTED TO BECOME DRY, LARGE DEEP CRACKS MAY FORM ALLOWING THE WASTEWATER TO INFILTRATE INTO THE SOIL.

3. TO PREVENT GROWTH OF DEEP ROOTED WEEDS AND/OR BRUSH, WHICH WOULD LOSEN UP THE SOIL AND DESTROY THE IMPERVIOUS LINER.

4. DEPENDING ON THE STRENGTH OF THE WASTEWATER UPON INITIAL START UP, SEPTIC CONDITIONS COULD OCCUR; HOWEVER, DILUTION OF THIS WASTEWATER BY THE INITIAL FILL WATER SHOULD DISCOURAGE SEPTIC CONDITIONS AND ALLOW NATURAL AEROBIC PROCESSES TO BEGIN WITHOUT DELAY.

5. WHEN START UP IS INITIATED SHORTLY BEFORE WINTER CONDITIONS SET IN, THE ADDITIONAL WATER WILL ALSO DISCOURAGE FREEZE UP OF DISCHARGE LINES AND CONTROL STRUCTURES.

E-3 WATER LEVEL CONTROL

GENERAL

BECAUSE PONDS DURING LOW WATER PERIODS MAY EXPERIENCE THE SAME PROBLEMS AS NEW PONDS, THE FOLLOWING PROCEDURE WILL COVER BOTH SITUATIONS. THERE ARE NUMEROUS SITUATIONS WHICH MAY DEVELOP, THEREFORE WE WILL COVER THE GENERAL SITUATIONS ONLY; HOWEVER, IF DIFFICULTIES IN OPERATION DO DEVELOP, PLEASE CONTACT THE MPCA.

AT ALL TIMES THE WATER VOLUME IN THE PONDS SHOULD BE PROPERLY CONTROLLED AND CALCULATED SO THAT THE POND DEPTH WILL REACH MAXIMUM CAPACITY AT THE ANTICIPATED DISCHARGE DATE. WATER GREATLY ASSISTS IN THE OVERALL TREATMENT PROCESS AND PROTECTION OF THE FACILITY. FOR EXAMPLE, WATER DISCOURAGES VEGETATION GROWTH

PROTECTS THE SEAL, PROVIDES DILUTION, AND PERMITS A GREATER BIOMASS VOLUME; HOWEVER, EXCESS WATER MAY ENCOURAGE EROSION AND MUST BE KEPT IN CHECK AT ALL TIMES.

E-4 WATER LEVEL CONTROL CONSIDERATIONS

1. NEW PONDS MUST BE PREFILLED OR STERILIZED PRIOR TO ADDITION OF WASTEWATER.
2. WHEN FILLING FROM ONE POND TO ANOTHER, UTILIZATION OF TOP DRAW-OFF THROUGH GATE ADJUSTMENTS IS RECOMMENDED. IF BOTTOM DRAW-OFF VALUES ARE USED, YOU WILL NOT ACHIEVE THE ALGAE REDUCTION EXPECTED THROUGH SERIES OPERATION.
3. THE DRAW-OFF LINE BETWEEN PONDS SHOULD BE CONSTRUCTED IN SUCH A MANNER THAT WATER IS DRAWN FROM A MINIMUM OF ONE FOOT OFF THE BOTTOM OF THE POND (THIS IS DISCUSSED IN THE TROUBLE SHOOTING SECTION OF THIS MANUAL).
4. WHENEVER THE SECONDARY CELL HAS TO RECEIVE ADDITIONAL WATER DURING WINTER MONTHS, TAKE CARE TO INSURE THAT TOTAL ICE BLOCKAGE BETWEEN PONDS DOES NOT OCCUR DUE TO SHALLOW WATER LEVELS.
5. FILLING OF THE SECONDARY CELL TO MAXIMUM OPERATING DEPTH AS FAR AHEAD OF THE NEXT INTENDED DISCHARGE AS POSSIBLE WILL ALLOW GREATER TIME FOR THE INTENDED EFFLUENT TO CLARIFY. AGAIN, TAKE CARE NOT TO LOWER THE PRIMARY CELL BELOW THE MINIMUM OPERATING DEPTH.

6. PLEASE NOTE THAT THE SECONDARY POND IS GENERALLY THE POND WHICH DETERIORATES FIRST, USUALLY DUE TO LACK OF MAINTENANCE AND BECAUSE INFLUENT WATER VOLUMES IN NEW SYSTEMS ARE GENERALLY NOT GREAT ENOUGH TO FILL PONDS BEFORE PROBLEM SITUATIONS DEVELOP.

7. DURING THE SUMMER MONTHS IT IS USUALLY MORE DESIRABLE TO OPERATE THE PONDS IN SERIES. PROVIDED THAT THE ORGANIC LOAD IS NOT TOO GREAT FOR ONE CELL TO TREAT PROPERLY AND SEPTIC CONDITIONS DO NOT DEVELOP. THE REASON FOR THE SERIES OPERATION IS THAT ALGAE TENDS TO ACCUMULATE AND REMAIN IN EACH OF THE CELLS; THEREFORE, THE AMOUNT OF ALGAE IN THE WASTEWATER IS REDUCED AS TH AS THE WASTEWATER PROGRESSES FROM CELL TO CELL.

(Series Operation: Wastewater is discharged to the first cell and thereafter transferred to each following cell one after the other.)

8. IF A SYSTEM HAS MULTIPME PRIMARY CELLS, THEY SHOULD BE OPERATED IN PARALLEL DURING WINTER OPERATIONS BECAUSE THE DECOMPOSITION PROCESS IS SLOWER DURING THE COLDER MONS. THEREFORE, BY UTILIZING ALL PRIMARIES DURING THE WINTER THERE IS A GREATER DILUTION AND THEREFORE MORE ORGANISMS TO WORK ON THE BOD.

(Parallel Operation: requires discharging influent in equal amounts to all primaries. This is accomplished by either splitting the flow or alternating flows from one cell to the other in equal volumes.)

WITH THE ABOVE CONDITIONS TAKEN INTO CONSIDERATION, POND LEVEL CONTROL SHOULD BE RELATIVELY STANDARD USING EITHER OF THE FOLLOWING PROCEDURES.

E-5 WATER LEVEL CONTROL FOR SERIES OPERATED PONDS

See figure 14

1. OUTLET CONTROL STRUCTURE BETWEEN ALL PONDS SHOULD BE SHUT OFF TO STOP WATER TRANSFER BETWEEN CELLS AND STOP ALL DISCHARGES.
2. INFLUENT SHOULD BE DISCHARGED TO THE FIRST CELL IN THE SERIES UNTIL IT REACHES A MINIMUM OF THREE FEET AND/OR A MAXIMUM OF FIVE FEET.
3. ONCE THE WATER IN THE FIRST CELL REACHES THREE FEET LEVEL, THE ADDITIONAL WATER SHOULD BE TRANSFERRED TO THE REMAINING CELL(S) UNTIL THEY ARE ALL AT A MINIMUM OF THREE FEET. HOWEVER, YOU SHOULD BE CAREFUL NOT TO LOWER ANY PRIMARY CELL BELOW THREE FEET.
4. WITH ALL CELLS AT THE THREE FOOT LEVEL, ADD ADDITIONAL GATES TO ALLOW ALL CELLS TO FILL AN ADDITIONAL SIX INCHES. ALL CELLS SHOULD THEN BE ALLOWED TO EQUALIZE AT 3.5 FEET AGAIN, HOWEVER, THEY SHOULD FILL FROM FIRST TO LAST CELL AND NOT ALL AT THE SAME TIME.
5. THIS STEP METHOD SHOULD THEN BE CONTINUED UNTIL ALL CELLS ARE FULL OR DISCHARGE IS NECESSARY.

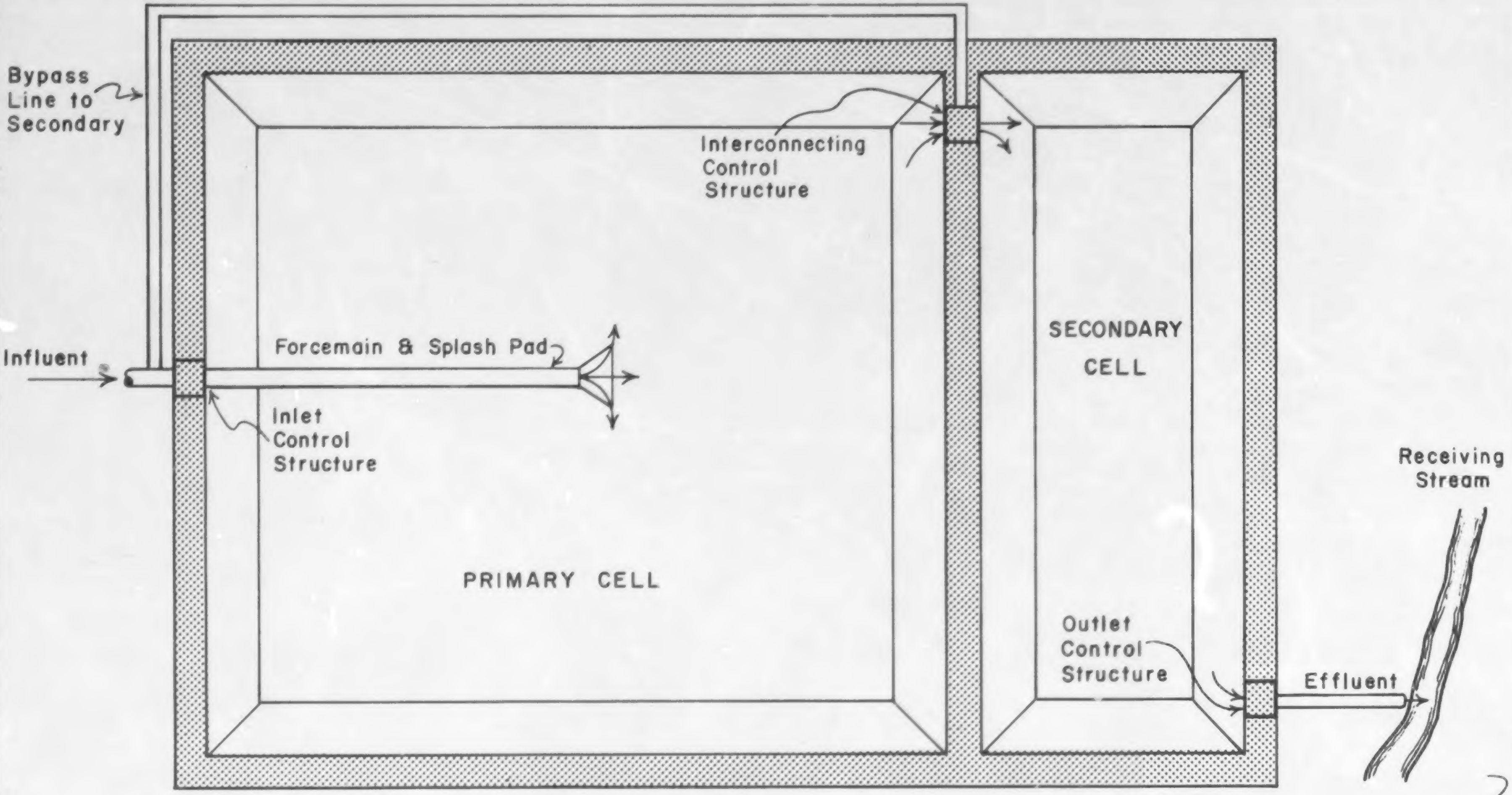
NOTE: WHEN SECONDARY POND BOTTOM IS LOWER THAN THE PRIMARY POND BOTTOM, FILL THE SECONDARY AND SHUT OFF ALL WATER ENTERING IT AT LEAST ONE MONTH PRIOR TO TAKING DISCHARGE TESTS

E-6 WATER LEVEL CONTROL FOR PARALLEL OPERATED PONDS.

(see figures 15 *and* 16 *)*

1. OUTLET CONTROL STRUCTURES BETWEEN PRIMARY CELL(S) AND SECONDARY CELL(S) SHOULD BE CLOSED. ALSO, OUTLET FROM SECONDARY CELL SHOULD BE CLOSED.
2. INFLUENT SHOULD BE DISCHARGED TO THE PRIMARY CELL(S) IN EQUAL VOLUMES UNTIL THEY REACH A MINIMUM OF THREE FEET AND/OR A MAXIMUM OF FIVE FEET.
3. ONCE THE WATER IN THE PRIMARY CELL(S) REACHES THE THREE FOOT LEVEL, THE ADDITIONAL WATER SHOULD BE TRANSFERRED TO THE REMAINING CELL(S) UNTIL THEY ARE ALL AT A MINIMUM OF THREE FEET. HOWEVER, YOU MUST BE CAREFUL NOT TO LOWER ANY PRIMARY CELL(S) BELOW THREE FEET.
4. WITH ALL CELLS AT THE THREE FOOT LEVEL, ADD ADDITIONAL GATES TO ALLOW ALL CELLS TO FILL AN ADDITIONAL SIX INCHES. ALL CELLS SHOULD THEN BE ALLOWED TO EQUALIZE AT 3.5 FEET AGAIN. HOWEVER, THEY SHOULD FILL FROM PRIMARIES TO SECONDARIES AND NOT ALL AT THE SAME TIME.
5. THE STEP METHOD SHOULD THEN BE CONTINUED UNTIL ALL CELLS ARE FULL.

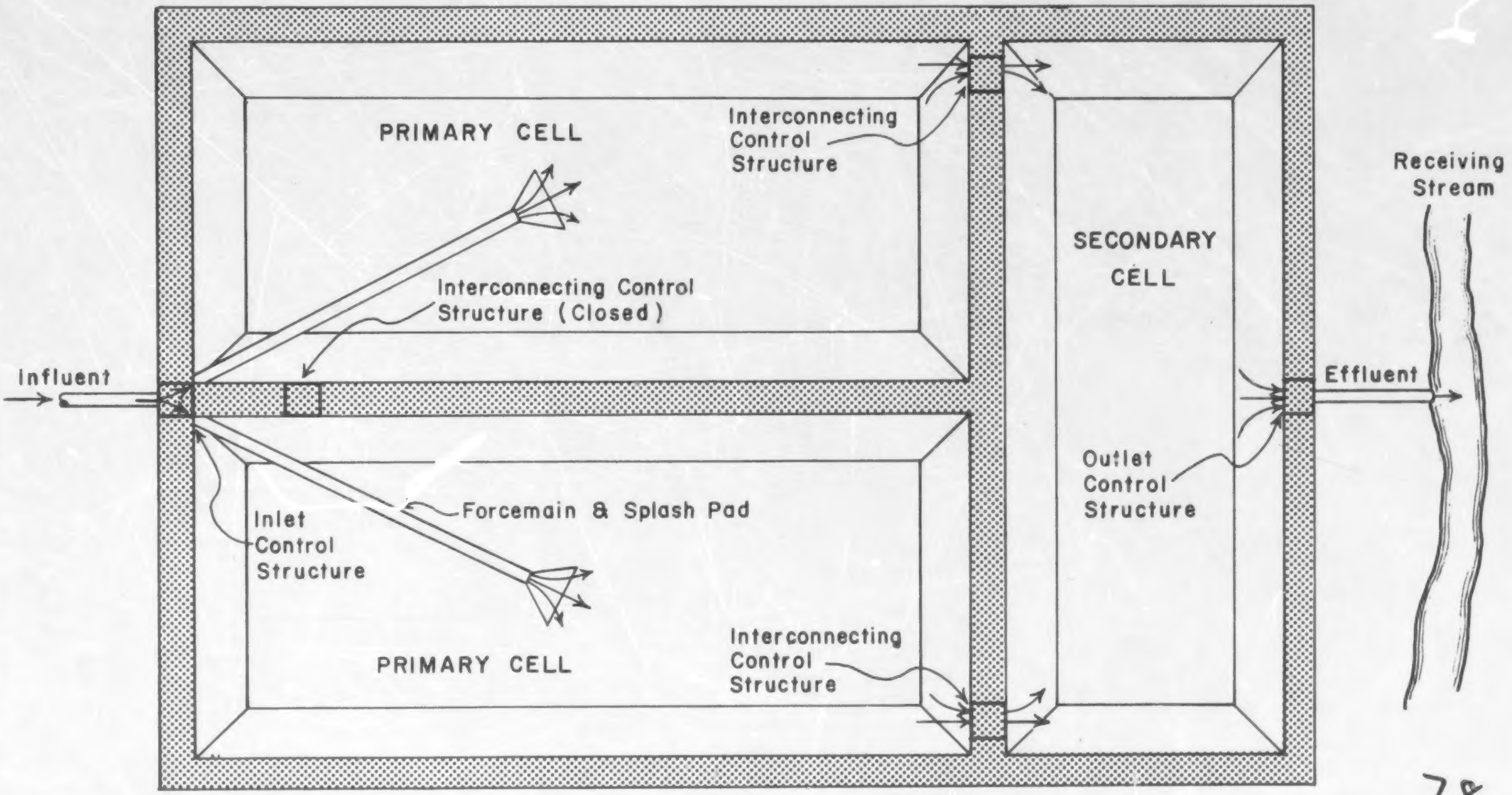
STABILIZATION PONDS
SINGLE CELLED PRIMARY


Bypass Line to Secondary
Interconnecting Control Structure
Influent
Forcemain & Splash Pad
Inlet Control Structure
SECONDARY CELL
PRIMARY CELL
Receiving Stream
Outlet Control Structure
Effluent

MINN. POLLUTION
CONTROL AGENCY
DIV. OF WATER QUALITY
SECTION OF
MUNICIPAL WORKS

STABILIZATION PONDS

MULTI-CELLED PRIMARY - PARALLEL OPERATION


PRIMARY CELL
Interconnecting Control Structure
Interconnecting Control Structure (Closed)
Receiving Stream
SECONDARY CELL
Influent
Effluent
Outlet Control Structure
Inlet Control Structure
Forcemain & Splash Pad
PRIMARY CELL
Interconnecting Control Structure

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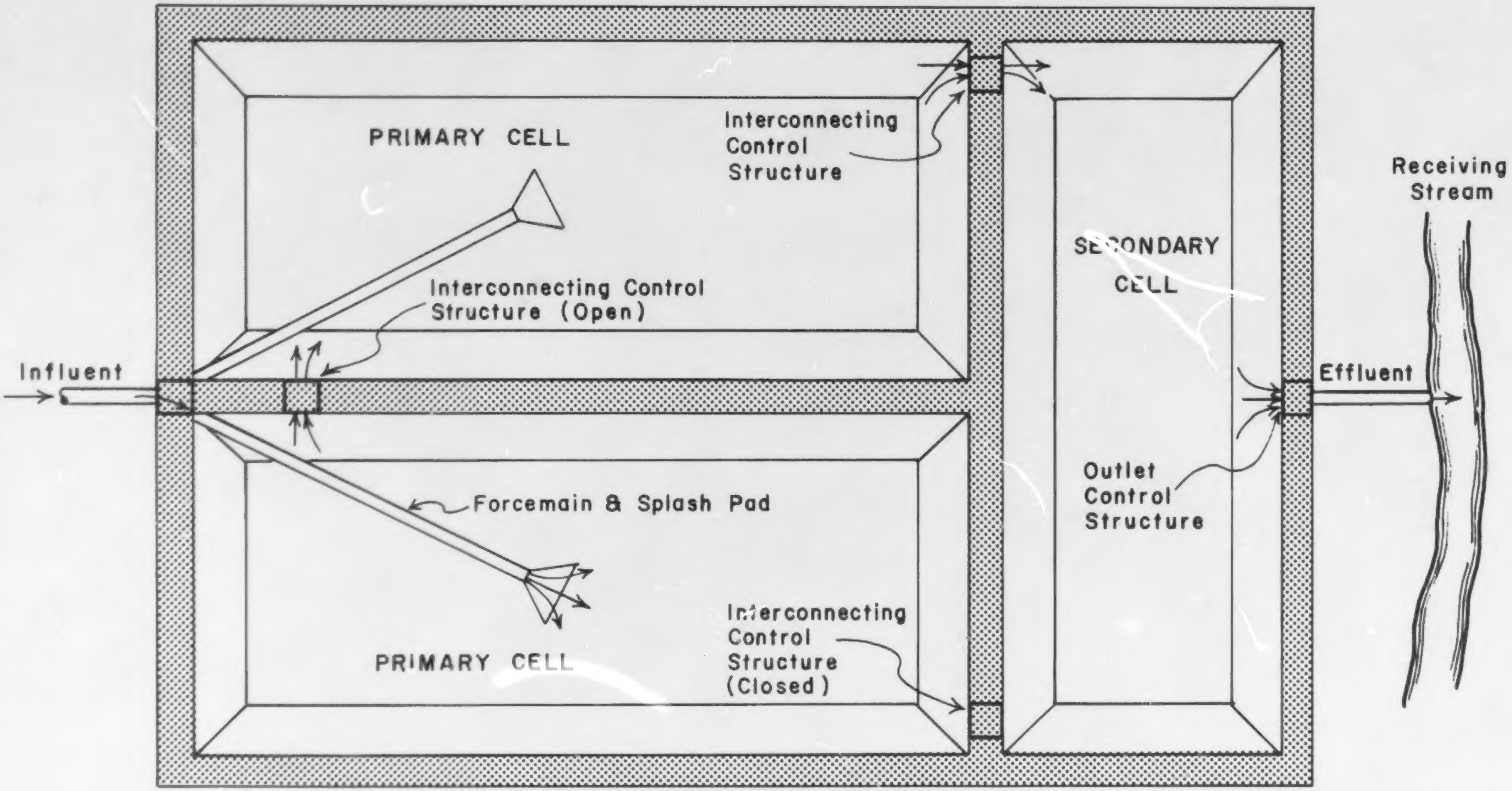
MINN. POLLUTION
CONTROL AGENCY
DIV. OF WATER QUALITY
SECTION OF
MUNICIPAL WORKS

STABILIZATION PONDS
MULTI-CELLED PRIMARY - SERIES OPERATION


PRIMARY CELL
Interconnecting Control Structure
Receiving Stream
SECONDARY CELL
Interconnecting Control Structure (Open)
Influent
Effluent
Forcemain & Splash Pad
Outlet Control Structure
Interconnecting Control Structure (Closed)
PRIMARY CELL

MINN. POLLUTION
CONTROL AGENCY
DIV. OF WATER QUALITY
SECTION OF
MUNICIPAL WORKS

Fig. 16

E-7 RECOMMENDED PROCEDURE FOR DISCHARGING STABILIZATION PONDS.

GENERAL

THE FOLLOWING GUIDELINES ARE OUTLINED TO CLARIFY THE PROCEDURES TO BE FOLLOWINGE WHEN DISCHARGING WASTEWATER STABILIZATION PONDS. EACH OF THE SIX STEPS WHICH ARE LISTED BELOW WILL BE EXPANDED ON IN MORE DETAIL IN THIS SECTION.

1. DETERMINE IF DISCHARGE IS NECESSARY AND AMOUNT;
2. SAMPLING PRIOR TO DISCHARGE;
3. REQUEST DISCHARGE PERMISSION;
4. DISCHARGING PROCEDURES;
5. SAMPLING DURING DISCHARGE; AND
6. MONTHLY REPORT OF RESULTS.

1. DISCHARGE DETERMINATION

NORMALLY, A DISCHARGE OF ANY WASTEWATER STABILIZATION POND SHOULD OCCUR (OR BE RESTRICTED) TO THE SPRING AND FALL (OR NON-RECREATIONAL) TIMES OF THE YEAR.

HOWEVER, PRIOR TO ANY DISCHARGE, THE FIRST STEP TAKEN BY THE POND OPERATOR IS TO DETERMINE IF A DISCHARGE IS ACTUALLY NECESSARY. THIS IS DONE BY CALCULATING THE STORAGE VOLUME THAT WILL BE NEEDED FOR THE NEXT PERIOD AND COMPARING THIS TO AVAILABLE STORAGE. IN MANY CASES, DISCHARGES ONLY ONCE A YEAR (OR VERY POSSIBLY NOT AT ALL) ARE SUFFICIENT (SEE NOTE BELOW) IF ONLY ONE DISCHARGE PER YEAR IS NECESSARY, THE OPERATOR SHOULD EXPLORE A FALL, RATHER THAN A SPRING DISCHARGE (PROVIDING ADEQUATE DILUTION IN THE RECEIVING WATERS IS AVAILABLE). IN

ADDITION, PLEASE REALIZE THAT ONLY THE REQUIRED STORAGE CAPACITY SHOULD BE MADE AVAILABLE WHICH IS NOT USUALLY THE ENTIRE CONTENTS OF THE POND(S). EXCESSIVE DISCHARGE WILL ONLY CAUSE INCREASED COSTS, ADDITIONAL WORK, AND ENHANCE PROBLEMS WITHIN THE POND(S).

If a discharge is not necessary, we would request that the operator indicate why, such as low influent flow, ponds are too large, leakage, etc., in the space provided for remarks on the monthly report form.

REMEMBER, THE WHOLE CONCEPT AND DESIGN OF A WASTEWATER STABILIZATION POND IS FOR THE RELEASE OF ITS CONTENTS DURING A PERIOD OF TIME WHEN ADEQUATE DILUTION IS AVAILABLE.

2. SAMPLING PROCEDURES

PRIOR TO ANY POND DISCHARGE, REPRESENTATIVE POND SAMPLES SHALL BE TAKEN TO DETERMINE POND EFFLUENT QUALITY. THESE SHOULD BE TAKEN APPROXIMATELY TWO WEEKS PRIOR TO INITIATING THE DISCHARGE TO ALLOW TIME FOR LAB WORK AND THE OBTAINING OF PERMISSION TO DISCHARGE THE POND FROM THE MPCA.

A sample should not be taken during or immediately after excessive wind action and/or unusual climatic conditions. Sediment stirred up would probably cause the sample to be in violation of standards.

SAMPLES SHOULD BE TAKEN FROM AN AEROBIC STATE SECONDARY POND OR THE FINAL POND IN THE SYSTEM TO BE DISCHARGED, WHICHEVER APPLIES. (AEROBIC STATE REFERS TO A POND WHICH HAS HAD

TIME TO STABILIZE AFTER ICE DISSIPATION OR INTO WHICH PRIMARY EFFLUENT HAS NOT RECENTLY BEEN DISCHARGED IN LARGE QUANTITIES.) THESE REPRESENTATIVE GRAB SAMPLES SHOULD BE A COMPOSITE OF EQUAL PORTIONS OF FOUR EQUAL VOLUME GRAB SAMPLES, TAKEN AT DIFFERENT CORNER/SIDE LOCATIONS THROUGHOUT THE FINAL POND.

THE SAMPLE TAKEN IN THE POND SHOULD BE TAKEN AT LEAST EIGHT FEET FROM THE WATERS' EDGE AND ONE FOOT BELOW THE SURFACE; HOWEVER, NO AGITATION OF BOTTOM SEDIMENT SHOULD OCCUR.

LAB TESTS: THE SAMPLE SHOULD BE REFRIGERATED IMMEDIATELY OR PACKED IN ICE AND TRANSPORTED AS QUICKLY AS POSSIBLE TO THE LAB WHERE THE REQUIRED ANALYSES ARE TO BE CONDUCTED. FOR ADEQUATE TEST RESULTS, ALL TESTS SHOULD BE STARTED WITHIN 24 HOURS OF SAMPLING, EXCEPT THE FECAL COLIFORMS TEST, WHICH SHOULD BE STARTED WITHIN SIX HOURS OF SAMPLING.

Fecal coliform samples must be collected in a separate sterilized bottle.

PARAMETERS: THE MINIMUM ANALYSES TO BE CONDUCTED PRIOR TO ANY DISCHARGE ARE AS FOLLOWS:

FIVE-DAY BIOCHEMICAL OXYGEN DEMAND (BOD)
TOTAL SUSPENDED SOLIDS (TSS)
FECAL COLIFORM BACTERIA

HOWEVER, YOU SHOULD CONSULT YOUR NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) PERMIT TO MAKE SURE THAT ALL REQUIRED TESTS ARE CONDUCTED, (SUCH AS TOTAL PHOSPHORUS AND KJELDAHL NITROGEN.)

3. DISCHARGE PERMISSION

AFTER THE TEST RESULTS ARE OBTAINED YOU MUST CONTACT THIS AGENCY AND REQUEST PERMISSION TO DISCHARGE.

It may be to your advantage to contact your lab by telephone to insure a more rapid set of test results. Often times mix-ups through the mail have caused lengthly delays in discharges.

CONTACTING THE MPCA FOR PERMISSION CAN BE DONE BY EITHER MAIL OR TELEPHONE. HOWEVER, WE HAVE FOUND IN THE PAST, THAT MAIL HANDLING AGAIN HAS CAUSED PROBLEMS. IF YOU DO WRITE FOR PERMISSION AND DO NOT HEAR FROM US WITHIN SEVEN (7) DAYS, PLEASE CONTACT US BY PHONE.

AFTER RECEIVING PERMISSION, THE TESTS RESULTS RECEIVED BY THE LAB SHOULD BE TRANSFERRED ONTO THE MONTHLY OPERATION REPORT. PLEASE KEEP THE LAB SHEET FOR YOUR RECORDS AND ONLY SUBMIT A COPY OF THE MONTHLY OPERATION REPORT TO THE FOLLOWING ADDRESS:

MINNESOTA POLLUTION CONTROL AGENCY
1935 WEST COUNTY ROAD B-2
ROSEVILLE, MINNESOTA 55113

A COPY OF THIS REPORT MUST ALSO BE RETAINED BY THE OPERATOR.

IF THE CALCULATION MADE BY THE OPERATOR INDICATES THAT MORE STORAGE CAPACITY THAN IS PROVIDED BY ONE DISCHARGE IS NEEDED, THE OPERATOR MAY HAVE TO REFILL AND REQUEST PERMISSION TO DISCHARGE AGAIN.

TEST RESULTS: TO RECEIVE PERMISSION TO DISCHARGE YOUR POND, THE TEST RESULTS SHALL HAVE A 5-DAY BOD CONCENTRATION NOT

TO EXCEED 25 MILLIGRAMS PER LITER (MG/L); A TSS CONCENTRATION NOT TO EXCEED 30 MG/L, AND A FECAL COLIFORM BACTERIA COUNT NOT TO EXCEED 200 MOST PROBABLE NUMBER (MPN/100 ML).

IF YOUR TEST RESULTS DO NOT MEET THESE STANDARDS, PLEASE CONTACT THE MPCA ANYWAY, SO THAT SAMPLING TECHNIQUES CAN BE DISCUSSED TO HELP DETERMINE WHY STANDARDS WERE NOT MET.

If your sample does not meet standards, you may be required to retest, in this case, the same procedures as described above should be followed.

4. DISCHARGING

AFTER PERMISSION TO DISCHARGE HAS BEEN RECEIVED, YOU MAY BEGIN TO DISCHARGE. HOWEVER, YOU MUST CONDUCT THE FOLLOWING ADDITIONAL TESTS PRIOR TO THE ACTUAL DISCHARGE AND ENTER THOSE VALUES ON THE MONTHLY OPERATION REPORT;

D.O. (DISSOLVED OXYGEN) OF THE POND TO BE DISCHARGED;
pH (OF THE POND) TO BE DISCHARGED;
D.O. OF RECEIVING STREAM ABOVE THE OUTFALL.

AGAIN, OPERATORS SHOULD TRY TO GAGE THE DISCHARGE PERIOD SUCH THAT STREAM FLOW IS HIGH DURING DISCHARGE. THIS PROVIDES THE MAXIMUM AMOUNT OF DILUTION AND THEREFORE, A MINIMUM OF STREAM DEGRADATION.

DISCHARGE SHOULD BE ACCOMPLISHED BY THE PROPER USE OF THE SLIDE GATES, WEIRS, OR VALVES IN THE OUTFALL STRUCTURE. UTILIZATION OF GATE ADJUSTMENTS SHOULD ALLOW THE POND TO BE LOWERED TO THE 1 1/2 TO 1.0 FOOT LEVEL. AT NO TIME SHOULD THE POND BE

LOWERED BEYOND THE ONE FOOT LEVEL.

EXCEPT FOR POSSIBLE DESIGN VARIATION, (WHICH SHOULD BE DISCUSSED WITH AGENCY PERSONNEL FOR PROPER PROCEDURE VARIATION) THE BOTTOM DISCHARGE VALVES IN THE OUTFALL STRUCTURE ARE DESIGNED FOR EMERGENCY SITUATIONS ONLY AND SHOULD NOT BE USED FOR DISCHARGE OR SAMPLING. THE DISCHARGE SHOULD BE REGULATED SO THAT A MAXIMUM OF SIX INCHES OF EFFLUENT A DAY IS DISCHARGED. WHEN STREAM FLOW IS LOW, MUCH LOWER DISCHARGE VOLUMES MAY BE REQUIRED.

CAUTION SHOULD BE USED WHEN DISCHARGING SO A MINIMUM OF BOTTOM SCOURING OCCURS. A RAPID OR UNCONTROLLED DISCHARGE COULD CAUSE BOTTOM SCOURING, THEREBY DAMAGING THE POND SEAL AND/OR CAUSING THE DISCHARGE OF EXCESSIVE AMOUNTS OF SEDIMENT.

A MINIMUM OF TWO WEEKS OF ACTUAL DISCHARGE IS RECOMMENDED, HOWEVER, IF ONLY SMALL VOLUMES ARE TO BE DISCHARGED, THIS MAY BE SHORTENED.

5. SAMPLING DURING DISCHARGE:

THE FOLLOWING TESTS ARE TO BE CONDUCTED ON GRAB SAMPLES TAKEN TWICE PER WEEK DURING THE ACTUAL DISCHARGE:

BIOCHEMICAL OXYGEN DEMAND (BOD)
TOTAL SUSPENDED SOLIDS (TSS)
TURBIDITY
FECAL COLIFORM
EFFLUENT DISSOLVED OXYGEN
pH

CHLORINE USED (SEE NOTE 1)

CHLORINE RESIDUAL (SEE NOTE 1)

TOTAL PHOSPHORUS (SEE NOTE 2)

KJELDAHL NITROGEN (SEE NOTE 2)

RECEIVING WATERS D.O. (ABOVE AND BELOW OUTFALL)

1. *to be conducted only when disinfection is required.*
2. *to be conducted only if it is required in your NPDES permit or if the discharge is to or directly affects a lake or reservoir.*

DISINFECTION: DISINFECTION MAY BE REQUIRED, IF FECAL COLIFORM COUNTS ARE ABOVE APPROVED STANDARDS. THE APPLICATION AND DESIGN OF A PROPER DISINFECTION PROCEDURE AND TESTING SHOULD BE DISCUSSED WITH AGENCY PERSONNEL PRIOR TO DISCHARGE.

REFILL OF SECONDARY: WHEN REFILLING THE SECONDARY CELL, THE POND OPERATOR SHOULD AGAIN UTILIZE THE SLIDE GATES BETWEEN THE PONDS (AFTER FIRST CLOSING THE SECONDARY CELL EFFLUENT GATE). THIS REDUCES CARRY OVER OF SOLIDS FROM POND TO POND. AFTER THE SECONDARY HAS BEEN REFILLED TO AN ADEQUATE LEVEL, THE FLOW FROM THE PRIMARY POND SHOULD BE DISCONTINUED AND THE POND ALLOWED TO STABILIZE FOR A WEEK OR SO BEFORE DISCHARGE PROCEDURES ARE AGAIN UNDERTAKEN. (IF A SECOND DISCHARGE IS NECESSARY THE SAME PROCEDURE AS USED FOR THE FIRST DISCHARGE SHOULD BE FOLLOWED. AN OPERATOR MUST OBTAIN PERMISSION FOR A SECOND DISCHARGE AS HE DID FOR THE FIRST DISCHARGE.)

5. COMPLETION OF DISCHARGE

AFTER COMPLETION OF DISCHARGE, THE RESULTS OF TESTS DURING DISCHARGE SHOULD BE PUT ON THE MONTHLY REPORT FORM. (IF THE RESULTS ARE NOT RECEIVED IN TIME, THEN SUBMIT ON THE NEXT MONTH'S REPORT.) IN ADDITION, ANY RELATED CIRCUMSTANCE THAT YOU FEEL HAD AN AFFECT ON THIS DISCHARGE SHOULD BE INCLUDED ON THE FORM SO THAT EVALUATION OF YOUR SYSTEM CAN MORE PROPERLY BE CONDUCTED BY THE OPERATIONS UNIT.

REMEMBER PONDS ARE NOT JUST A HOLE IN THE GROUND! THEY ARE A CAREFULLY DESIGNED SYSTEM AND REQUIRE PROPER OPERATION AND REGULAR MAINTENANCE IF EXTENSIVE AND EXPENSIVE RENOVATION ARE TO BE ELIMINATED.

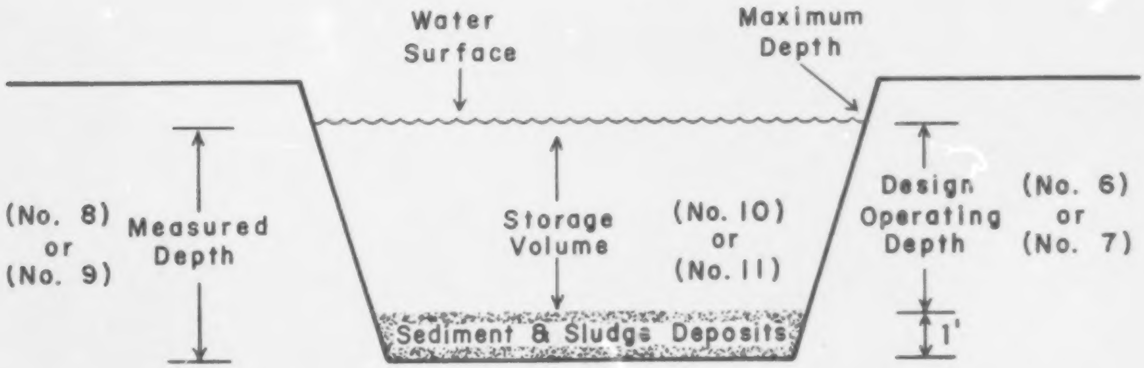
E-8 EXAMPLE PROBLEM FOR CALCULATING THE DISCHARGE VOLUME

PROBLEM

IT IS OCTOBER 29, 1975 MR. SCHLITZ, THE OPERATOR AT SUDSVILLE HAS TAKEN HIS SAMPLE, HAD THE APPROPRIATE TESTS CONDUCTED, REFERRED THE RESULTS TO THE AGENCY AND RECEIVED PERMISSION TO DISCHARGE HIS POND SYSTEM TO PROVIDE ADEQUATE STORAGE FOR THE WINTER.

GIVEN THE FOLLOWING INFORMATION, DETERMINE THE VOLUME OF WATER THAT HAS TO BE REMOVED TO PROVIDE STORAGE:

A) MEAN SURFACE AREA OF PRIMARY POND = 6 ACRES
B) MEAN SURFACE AREA OF SECONDARY POND = 3.75 ACRES
C) DAILY AVERAGE FLOW IN GALLONS PER DAY = 35,000 GPD
D) SINGLE DISCHARGE EXPECTED = 15 DAYS
E) DESIGN OPERATING DEPTH OF PRIMARY POND = 4 FEET
F) DESIGN OPERATING DEPTH OF SECONDARY POND = 4 FEET
G) MEASURED DEPTH OF PRIMARY POND = 3 FEET
H) MEASURED DEPTH OF SECONDARY POND = 4 FEET


Water Surface
Maximum Depth
(No. 8) or (No. 9)
Measured Depth
Storage Volume
(No. 10) or (No. 11)
Design Operating Depth
(No. 6) or (No. 7)
Sediment & Sludge Deposits
1'

DIRECTIONS: TO WORK THIS PROBLEM REQUIRES FOLLOWING THE DIRECTIONS FOR OBTAINING THE ANSWER GIVEN IN THE BOX BELOW THE PROBLEM. MOST PROBLEMS HAVE TWO BOXES UNDER THEM; EITHER BOX IF FOLLOWED WILL GIVE THE CORRECT ANSWER. THE MOST IMPORTANT THING TO REMEMBER IS THAT THE QUESTIONS MUST BE ANSWERED IN ORDER FROM 1 TO 18 TO OBTAIN CORRECT ANSWERS.

NOTE: This procedure can be used for your pond system by using the values relative to your own pond. Also note that all the numbers preceded by an asterisk are constant for all your discharges once you have calculated them for your pond system.

EXAMPLE PROCEDURE

*NO. 1 MEAN SURFACE AREA OF PRIMARY POND IN ACRES:

> OBTAIN FROM CONSTRUCTION OR NPDES PERMIT

NO. 1 = ____________ ACRES

*NO. 2 MEAN SURFACE AREA OF SECONDARY POND IN ACRES:

> OBTAIN FROM CONSTRUCTION OR NPDES PERMIT

NO. 2 = ____________ ACRES

NO. 3 DAILY AVERAGE FLOW IN GALLONS PER DAY:

> DETERMINE BY USE OF FLOW METER OR ESTIMATE FROM CITY WATER USAGE

NO. 3 = ____________ GPD

NO. 4 DAYS TO NEXT EXPECTED DISCHARGE:

> USUALLY 180 DAYS FROM END OF NOVEMBER TO END OF APRIL (WINTER)

OR

> BEGINNING OF MAY TO END OF OCTOBER (SPRING)

NO. 4 = ____________ DAYS

NO. 5 DAYS NEEDED TO DISCHARGE POND(S) (ESTIMATE):

> FOR SINGLE DISCHARGE APPROXIMATELY 15 DAYS;
> FOR DOUBLE DISCHARGE APPROXIMATELY 30 DAYS.

NO. 5 = ____________ DAYS

*NO. 6 DESIGN OPERATING DEPTH OF PRIMARY POND:

THIS IS DEPTH IN FEET BETWEEN THE ONE FOOT DEPTH AND THE MAX. OPERATING DEPTH, TAKEN FROM PERMIT

OR

FROM PLANS AND SPECIFICATIONS

NO. 6 = ____________ FEET

*NO. 7 DESIGN OPERATING DEPTH OF SECONDARY POND:

THIS IS DEPTH IN FEET BETWEEN THE ONE FOOT DEPTH AND THE MAX. OPERATING DEPTH TAKEN FROM PERMIT

OR

FROM PLANS AND SPECIFICATIONS

NO. 7 = ____________ FEET

NO. 8 MEASURED DEPTH OF PRIMARY POND PRIOR TO DISCHARGE:

OPERATOR SHOULD MEASURE DEPTH OF PONDS

NO. 8 = ____________ FEET

NO. 9 MEASURED DEPTH OF SECONDARY POND PRIOR TO DISCHARGE:

OPERATOR SHOULD MEASURE DEPTH OF PONDS

NO. 9 = ____________ FEET

NO. 10 STORAGE VOLUME OF PRIMARY POND IN GALLONS:

(MEAN SURFACE AREA OF PRIMARY POND IN ACRES) X (43,560 FEET PER ACRE) X (DESIGN OPERATINE DEPTH OF PRIMARY POND) X (7.5 GALLONS PER FOOT^3)

OR

(NO. 1) X (43,560)FT^2 X (NO. 6) X (7.5 GALLONS PER FOOT^3).

NO. 10 = ________ GALLONS

*NO. 11 STORAGE VOLUME OF SECONDARY POND IN GALLONS:

(MEAN SURFACE AREA OF SECONDARY POND IN ACRES) X (43,560 FEET PER ACRE) X (DESIGN OPERATING DEPTH OF SECONDARY POND) X (7.5 GALLONS PER FOOT^3).

OR

(NO. 2) X (43,560 FEET PER ACRE) X (NO. 7) X (7.5 GALLONS PER FOOT^3)

NO. 11 = ________ GALLONS

*NO. 12 AVERAGE VOLJME IN GALLONS PER FOOT DEPTH PRIMARY PONDS IN GALLONS:

$$\frac{\text{(STORAGE VOL. OF PRIMARY PONDS IN GALLONS)}}{\text{(DESIGN OPERATING DEPTH OF PRIMARY PONDS)}}$$

OR

$$\frac{\text{(NO. 10)}}{\text{(NO. 6)}}$$

NO. 12 = ________ GALLONS/ FOOT

*NO. 13 AVERAGE VOLUME IN GALLONS PER FOOT DEPTH SECONDARY POND:

$$\frac{\text{(STORAGE VOL. OF SECONDARY POND IN GALLONS)}}{\text{(DESIGN OPERATING DEPTH OF SECONDARY POND)}}$$

OR

$$\frac{\text{(NO. 11)}}{\text{(NO. 7)}}$$

NO. 13 = ________ GALLONS/ FOOT

NO. 14 STORAGE AREA LEFT IN PRIMARY POND:

(DESIGN OPERATING DEPTH OF PRIMARY POND + 1' - MEASURED DEPTH OF PRIMARY POND PRIOR TO DISCHARGE) X (AVERAGE VOLUME IN GALLONS PER FOOT DEPTH PRIMARY POND).

OR

[(NO. 6 + 1 FOOT) - NO. 8] X (NO. 12)

NO. 14 = ________ GALLONS

NO. 15 STORAGE AREA LEFT IN SECONDARY POND

(DESIGN OPERATING DEPTH OF SECONDARY POND + 1' - MEASURED DEPTH OF SECONDARY POND PRIOR TO DISCHARGE) X (AVERAGE VOLUME IN GALLONS PER FOOT DEPTH SECONDARY POND)

OR

[(NO. 7 + 1 FOOT) - NO. 9] X (NO. 13)

NO. 15 = ________ GALLONS

NO. 16 VOLUME OF STORAGE AREA NEEDED:

(DAYS TO NEXT EXPECTED DISCHARGE + DAYS NEEDED TO DISCHARGE PONDS) X (DAILY AVERAGE FLOW IN GALLONS PER DAY)

OR

[(NO. 4 + NO. 5)] X (NO. 3)

NO. 16 = ________ GALLONS

NO. 17 VOLUME TO BE DISCHARGED:

(VOLUME OF STORAGE AREA NEEDED) - (VOLUME OF STORAGE AREA LEFT IN PRIMARY POND + VOLUME OF STORAGE AREA LEFT IN SECONDARY POND)

OR

(NO. 16 - (NO. 14 + NO. 15)

NO. 17 = ________ GALLONS

NO. 18 DEPTH TO REMOVE IN FEET FROM SECONDARY POND:

$$\frac{\text{(VOLUME TO BE DISCHARGED)}}{\text{(AVERAGE VOL. IN GAL. PER FT. DEPTH SECONDARY POND)}}$$

OR

$$\frac{\text{(NO. 17)}}{\text{(NO. 13)}}$$

NO. 18 = ________ FEET

*VALUES THAT ARE CONSTANT FOR EACH DISCHARGE

ANSWER SHEET

NO. 1 = 6 ACRES

NO. 2 = 3.75 ACRES

NO. 3 = 35,000 GPD

NO. 4 = 180 DAYS

NO. 5 = 15 DAYS

NO. 6 = 4 FEET

NO. 7 = 4 FEET

NO. 8 = 3 FEET

NO. 9 = 4 FEET

NO. 10 6 ACRES X 43,560 FT^2/ACRE X 4 FEET X 7.5 GAL/FT^3 =

(261,360 FT^2) X 4 FEET X 7.5 GAL/FT^3 =

(1,045,440 FT^3) X 7.5 GAL/FT^3 =

7,840,800 GALLONS

NO. 11 3.75 ACRES X 43,560 FT^2/ACRE X 4 FEET X 7.5 GAL/FT^3 =

(163,350 FT^2) X 4 FEET X 7.5 GAL/FT^3 =

(653,400 FT^3) X 7.5 GAL/FT^3 =

4,900,500 GALLONS

NO. 12 $\frac{\text{7,840,800 GALLONS}}{\text{4 FEET}}$ = 1,960,200 GALLONS/FOOT

NO. 13 $\frac{\text{4,900,500 GALLONS}}{\text{4 FEET}}$ = 1,225,125 GALLONS/FOOT

NO. 14 [(4 FEET + 1 FOOT) - 3 FEET] X 1,960,200 GALLONS/FOOT =

[(5 FEET) - 3 FEET] X 1,960,200 GALLONS/FOOT =

[2 FEET] X 1,960,200 GALLONS/FOOT =

3,920,400 GALLONS

NO. 15 [(4 FEET + 1 FOOT) - 4 FEET] X 1,225,125 GALLONS/FOOT =

[(5 FEET) - 4 FEET] X 1,225,125 GALLONS/FOOT =

[1 FOOT] X 1,225,125 GALLONS/FOOT =

1,225,125 GALLONS

NO. 16 [(180 DAYS + 15 DAYS)] X 35,000 GALLONS/DAY =

(195 DAYS) X 35,000 GALLONS/DAY =

6,825,000 GALLONS

NO. 17 (6,825,000 GALLONS) - (3,920,400 GALLONS + 1,225,125 GAL) =

(6,825,000 GALLONS) - (5,145,525 GALLONS) =

1,679,475 GALLONS

NO. 18 $\frac{\text{1,679,475 GALLONS}}{\text{1,225,125 GALLONS/FOOT}}$ = 1.37 FEET

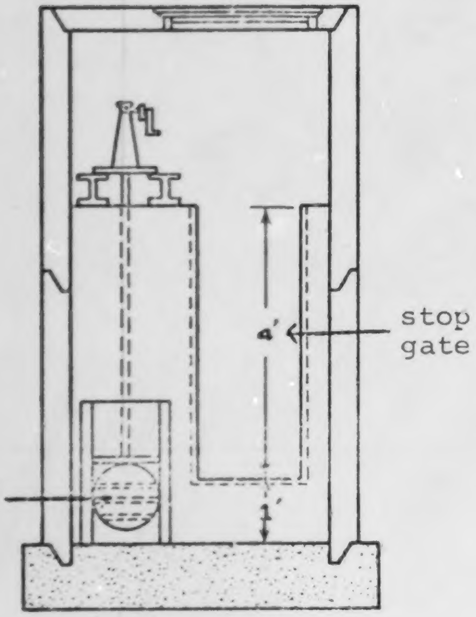
SUMMARY

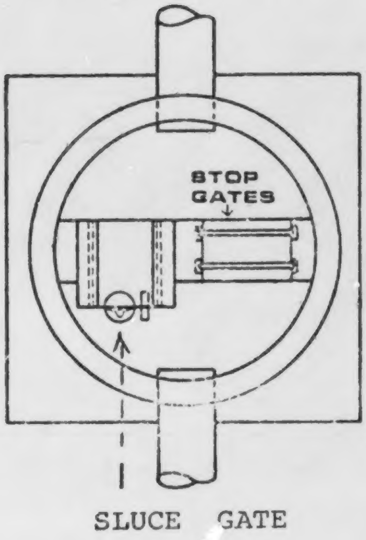
SUDSVILLE, BECAUSE OF THE ELEVATION DIFFERENCE, IS A VERY WORKABLE SYSTEM. THE 0 FOOT LEVEL IN THE PRIMARY POND CORRESPONDS TO THE FIVE FOOT LEVEL IN THE SECONDARY POND, ALLOWING TOTAL DRAINAGE OF THE PRIMARY POND WITHOUT HAVING TO DRAIN THE SECONDARY POND. WHEN ALL THE CELLS OF A POND SYSTEM ARE BUILT AT THE SAME ELEVATION, MULTIPLE DISCHARGES AND POSSIBLY UTILIZATION OF PUMPS BETWEEN PRIMARY POND AND THE SECONDARY POND MUST BE INCORPORATED TO FACILITATE A WORKABLE SYSTEM AS THE SYSTEM APPROACHES DESIGN LOADINGS.

AFTER THE FINAL DISCHARGE IN THE FALL, THE SECONDARY POND SHOULD BE FILLED TO THE MAXIMUM POSSIBLE DEPTH WITHOUT LOWERING THE PRIMARY POND TO THE DEPTH WHERE FREEZE UP PROBLEMS COULD OCCUR. THIS PROCEDURE SHOULD ALSO DETER FREEZE UP PROBLEMS IN THE TRANSFER STRUCTURE BETWEEN PONDS.

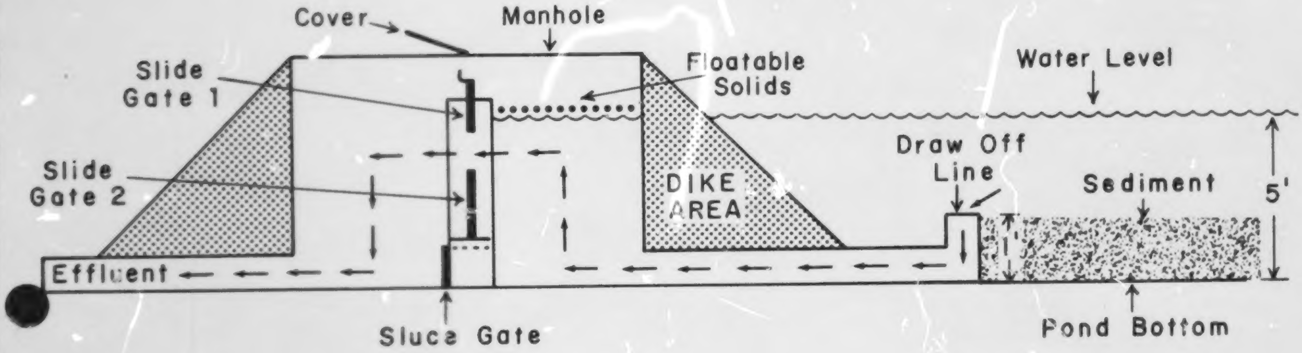
OVERFLOW STRUCTURES

OVERFLOW STRUCTURES USUALLY CONSIST OF A MANHOLE OR BOX EQUIPPED WITH MULTIPLE-VALVED POND DRAW OFF LINES OR AN ADJUSTABLE OVERFLOW DEVICE SO THAT THE LIQUID LEVEL OF THE PONDS CAN BE ADJUSTED (AS SHOWN IN ILLUSTRATIONS BELOW). FOR LEVEL CONTROLS AND DRAW DOWN, AN OPERATOR SHOULD ONLY UTILIZE THE SLIDE GATES IN THE CONTROL STRUCTURE AND DRAW DOWN FROM NEAR THE SURFACE. THE SLUICE GATES PROVIDED ARE FOR EMERGENCY SITUATIONS, AND SHOULD NOT BE USED FOR NORMAL POND LEVEL CONTROL.


stop gate
4'
sluce gate
1'


STOP GATES
SLUCE GATE

IN THE DIAGRAM SHOWN BELOW, SLIDE GATE NO. 1 HAS BEEN RAISED 6 INCHES; HOWEVER, THE BOTTOM OF THE GATE IS STILL BELOW THE WATER SURFACE, ENOUGH SO THAT AFTER A DAYS DRAW DOWN, IT WILL STILL BE BELOW THE WATER SURFACE. IN THIS POSITION, SLIDE GATE NO. 1 WILL ALLOW BETTER FLOW REGULATION, AND ALSO ACT AS A BAFFLE, TRAPPING FLOATABLE SOLIDS IF THE VELOCITY OF FLOW THROUGH THE MANHOLE IS NOT TOO GREAT.


Cover
Manhole
Slide Gate 1
Floatable Solids
Water Level
Slide Gate 2
DIKE AREA
Draw Off Line
Sediment
5'
1'
Effluent
Sluce Gate
Pond Bottom

SECTION F

MAINTENANCE PRACTICES

F-1 GENERAL

ALTHOUGH WASTE STABILIZATION PONDS REQUIRE A MINIMUM AMOUNT OF MAINTENANCE, THEY CANNOT BE EXPECTED TO PROVIDE ADEQUATE TREATMENT WITHOUT PROPER ATTENTION. IF PONDS ARE NEGLECTED, THEY CAN DETERIORATE TO THE POINT WHERE VERY COSTLY REPAIRS AND POSSIBLY RECONSTRUCTION ARE REQUIRED.

F-2 VEGETATION CONTROL WITHIN THE PONDS

VEGETATION IN THE PONDS MUST BE KEPT TO A MINIMUM TO PREVENT THE PONDS FROM BECOMING A WEEDY SWAMP AND A HARBORAGE FOR INSECTS. UNWANTED VEGETATION INCLUDES SUBMERGED WATER WEEDS, MARSH PLANTS, ROOTED PLANTS WITH FLOATING LEAVES AND SHRUBS OR TREES.

GENERALLY THE SUBMERGED WATER WEEDS SUCH AS HORNWORT (COONTAIL), BLADDERWORT, ELODEA, NAIAD, AND THE POTAMOGETONS, THE ROOTED PLANTS WITH FLOATING LEAVES, SUCH AS WATER LILIES AND WATERSHIELD, SHOULD NOT BE A PROBLEM IF THE PONDS ARE KEPT FILLED TO THE SUMMER OPERATING DEPTH OF AT LEAST THREE FEET. UNDER THESE CONDITIONS, ALGAE WILL GENERALLY REDUCE LIGHT PENETRATION AND SUBSEQUENTLY INHIBIT GROWTH OF OTHER VEGETATION. FLOATING PLANTS SUCH AS DUCKWEED CAN FLOURISH IF THE PONDS ARE NOT EXPOSED TO THE CLEAN SWEEP OF THE WIND. DUCKWEED CAN

BE REMOVED BY SEINING OR MAY BE DESTROYED BY SPRAYING; HOWEVER, A FEW TAME DUCKS PER ACRE OF DUCKWEED SHOULD KEEP IT UNDER CONTROL. SHRUBS AND TREES SUCH AS WILLOWS, ALDERS, BUTTON BRUSH, COTTONWOODS, BRIARS AND WOODY VINES ARE MOST EASILY CONTROLLED BY PULLING THEM DURING THEIR FIRST YEAR'S GROWTH.

MARSH PLANTS SUCH AS CATTAILS, RUSHES AND PENNYWORT ARE THE MOST COMMON TROUBLESOME ROOTED VEGETATION IN THE PONDS. THEY USUALLY BECOME ESTABLISHED IN THE SHALLOW WATER ALONG THE EDGES OF THE POND. THEY CAN BECOME A PROBLEM THROUGHOUT THE ENTIRE POND IF THE DEPTH OF LIQUID IN THE POND IS NOT KEPT AT LEAST THREE FEET DURING THE SUMMER. SEVERAL METHODS OF CONTROL OF THE COMMON CATTAIL MAY BE ACCOMPLISHED AS FOLLOWS:

1. PULL THE NEW CATTAILS AS THEY APPEAR AND BEFORE THEY COLONIZE WITH EXTENDED ROOT GROWTH.
2. CUTTING BELOW THE WATER LINE COULD RETARD THE GROWTH.
3. FOR LARGE AREAS, THE CATTAILS SHOULD BE SPRAYED WITH A COMMERCIAL HERBICIDE; HOWEVER, THIS HERBICIDE MUST BE APPROVED BY THE MINNESOTA DEPARTMENT OF NATURAL RESOURCES AND APPLIED STRICTLY ACCORDING TO THE MANUFACTURER'S RECOMMENDATIONS.

   IT SHOULD BE KEPT IN MIND THAT HERBICIDES CAUSE SERIOUS IRRITATION OF THE SKIN AND MAY BE POISONOUS SO THEY MUST BE APPLIED AND HANDLED VERY CAREFULLY.

F-3 VEGETATION CONTROL ON THE DIKES AND SURROUNDING AREA

THE POND DIKES SHOULD BE PLANTED WITH A LOW-GROWING SPREAD-

ING GRASS IMMEDIATELY AFTER CONSTRUCTION TO PREVENT EXCESSIVE EROSION. GRASS SEED MIXTURES USED BY THE HIGHWAY DEPARTMENT FOR CONTROL OF EROSION ON STEEP SLOPES ARE RECOMMENDED. GRASSES SUCH AS RYE AND BROME HAVE A DENSE ROOT STRUCTURE AND WILL SPREAD EASILY BY RESEEDING. REED CANARY GRASS MAY ALSO BE GOOD FOR CONTROLLING EROSION AT THE WATER LINE SINCE IT WILL GROW SUBMERGED IN SHALLOW WATER; HOWEVER, IF THIS GRASS IS USED SPECIAL CARE SHOULD BE TAKEN TO KEEP IT UNDER CONTROL BY MOWING AT THE WATER LINE. THE GRASS ON TOP OF THE DIKES SHOULD BE MOWED SEVERAL TIMES EACH SEASON. GRAZING ANIMALS SHOULD NOT BE USED TO CONTROL VEGETATION SINCE THEY MAY CAUSE DAMAGE TO THE DIKES NEAR THE WATER LINE AND COULD POSSIBLY COMPLICATE EROSION PROBLEMS.

PLANTS WITH LONG ROOT STRUCTURES SUCH AS ALFALFA, WILLOWS AND OTHER SHRUBS SHOULD NOT BE PLANTED OR ALLOWED TO GROW ON THE DIKES SINCE THE ROOTS WILL IMPAIR THE WATER-HOLDING CAPACITY OF THE DIKES AND MAY EVENTUALLY CAUSE STRUCTURAL FAILURE AND COSTLY REPAIR.

F-4 EROSION CONTROL

THE DIKES SHOULD BE INSPECTED REGULARLY FOR EXCESSIVE EROSION AND BE REPAIRED IMMEDIATELY. ON LARGE PONDS, THE PROBLEM OF EROSION MAY BECOME QUITE SERIOUS DUE TO INCREASED SURFACE EXPOSURE TO WIND ACTION. USE OF COARSE GRAVEL OR OTHER RIP-RAP MATERIAL TO FILL IN THE ERODED AREAS ALONG THE DIKES MAY BE NECESSARY IN CASES OF SEVERE EROSION. CLOSE INSPECTION OF THE DIKES AROUND THE OVERFLOW STRUCTURES SHOULD ALLOW DETEC-

TION OF PROBLEMS AT THIS POTENTIAL WEAK SPOT BEFORE A MAJOR DIKE FAILURE OCCURS.

F-5 BURROWING ANIMALS

DIKES MAY BE SERIOUSLY DAMAGED BY BURROWING ANIMALS SUCH AS MUSKRATS, BADGERS AND GOPHERS. THE HOLES OF THESE ANIMALS MAY LEAD TO MAJOR FAILURE OF THE DIKE AND FLOODING OF SURROUNDING PROPERTY. SUCH A FAILURE COULD BE COSTLY TO THE COMMUNITY FROM THE STANDPOINT OF DIKE REPAIRS AND ALSO FROM LAWSUITS WHICH COULD EVOLVE FROM PROPERTY DAMAGE. THESE ANIMALS SHOULD BE ERADICATED AND THEIR BURROWED HOLES REPAIRED IMMEDIATELY.

F-6 FENCING AND WARNING SIGNS

THE POND AREA SHALL BE ENCLOSED WITH A SUITABLE FENCE TO PRECLUDE LIVESTOCK AND DISCOURAGE TRESPASSING. HOWEVER, THIS FENCE SHOULD BE LOCATED SO THAT DIKE MAINTENANCE IS NOT OBSTRUCTED. A VEHICLE ACCESS GATE OF SUFFICIENT WIDTH TO ACCOMODATE MOWING EQUIPMENT SHOULD BE PROVIDED. ALL ACCESS GATES SHOULD BE PROVIDED WITH LOCKS.

APPROPRIATE SIGNS SHOULD BE PROVIDED ALONG THE FENCE AROUND THE POND TO DESIGNATE THE NATURE OF THE FACILITY AND ADVISE AGAINST TRESPASSING.

F-7 SOLIDS ACCUMULATION

THERE IS A TENDENCY FOR THE SETTLEABLE PORTION OF THE SUSPENDED SOLIDS IN WASTEWATER TO ACCUMULATE NEAR THE INLET PIPE, ESPECIALLY DURING THE WINTER. THIS ACCUMULATION MAY SOMETIMES BE OBSERVED AS A SLUDGE BANK IN THE SPRING AT THE TIME THE ICE ON THE PONDS BREAKS UP. DURING THE PROCESS OF ANAEROBIC DIGESTION, GAS BY-PRODUCTS TEND TO ACCUMULATE IN THE SLUDGE CAUSING SMALL SLUDGE MASSES TO FLOAT. THESE FLOATING SLUDGE MASSES ARE THEN DISPERSED BY WIND ACTION THROUGHOUT THE POND. THEN, AS ENTRAPPED GASES ESCAPE FROM THESE SLUDGE MASSES, THEY SINK AGAIN THEREBY COMPLETING THE MECHANISM OF SLUDGE DISPERSION THROUGHOUT THE PRIMARY POND.

IF A POND HAS A PERSISTENT ACCUMULATION OF SOLIDS LOCATED AT THE END OF THE INFLUENT LINE, OTHER POSSIBLE PROBLEMS WITHIN THE SEWER SYSTEM SHOULD BE CHECKED. GENERALLY, EXCESS BUILD-UP IS DUE TO GRIT DEPOSITS WHICH COULD ORIGINATE FROM INFLOW/ INFILTRATION PROBLEMS OR INDUSTRIAL RELATED PROBLEMS.

F-8 SEEPAGE LOSS

THE CONTROL OF LIQUID LOST BY SEEPAGE THROUGH THE POND BOTTOM AND DIKES SHOULD BE NEGLIGIBLE IF PROPERLY COMPACTED AND SEALED DURING CONSTRUCTION. HOWEVER, THIS DOES NOT MEAN THAT SEEPAGE IS COMPLETELY PREVENTED BY THESE PROCESSES.

MANY SEALANTS CAN BE INCORPORATED IN POND CONSTRUCTION - ASPHALT, RUBBER LINER, CONCRETE, BENTONITE, CLAY AND CHEMICAL SEALANTS TO NAME A FEW. HOWEVER, THE USE OF A PARTICULAR SEALANT IS DEPENDENT ON THE COSTS INVOLVED FOR INSTALLATION.

EXCESS SEEPAGE CAN CAUSE PROBLEMS WITH POND OPERATION FROM AN ORGANIC LOAD-HYDRAULIC LOAD RELATIONSHIP. ALSO, SURROUNDING LAND AND/OR BODIES OF WATER AND/OR GROUND WATER MAY BE AFFECTED BY SEEPAGE POSSIBLY CAUSING POTENTIAL HEALTH AND POLLUTION PROBLEMS.

IT MUST BE REMEMBERED, HOWEVER, THAT EVAPORATION CAN PLAY A MAJOR ROLE IN WATER LOSSES AND SHOULD NOT BE MISTAKEN FOR SEEPAGE LOSSES. IF EXCESSIVE SEEPAGE IS SUSPECTED, THE ADVICE AND RECOMMENDATIONS OF A QUALIFIED SANITARY ENGINEER SHOULD BE OBTAINED REGARDING STEPS WHICH MIGHT BE TAKEN TO DETERMINE AND CONTROL THIS SEEPAGE.

F-9 ACCESS ROAD

THERE SHOULD BE AN ALL WEATHER ACCESS ROAD TO THE PONDS TO ELIMINATE NEGLECT OF MAINTENANCE DUE TO INACCESSIBILITY DURING PERIODS OF INCLEMENT WEATHER. ALSO, ACCESS ROADS ALLOW FOR THE REQUIRED REGULAR INSPECTIONS BY THE OPERATOR SO THAT OPERATION AND MAINTENANCE PROBLEMS CAN BE OBSERVED AND CORRECTED.

F-10 OPERATION AND MAINTENANCE COSTS

OPERATIONAL COSTS VARY WITH EACH INDIVIDUAL STABILIZATION POND SYSTEM. THE PRIMARY EXPENSE WILL BE ELECTRICAL SERVICE FOR OPERATION OF A LIFT STATION, WHICH IS USED FOR RELAYING OR PUMPING OF THE WASTEWATER INTO THE WASTE STABILIZATION PONDS.

ANOTHER COST IS THE INFLUENT AND EFFLUENT TESTING. THIS CAN BE ACCOMPLISHED BY THE OPERATOR OR BY CONTRACT WITH A RESPONSIBLE PRIVATE LABORATORY.

IT SHOULD BE POINTED OUT THAT THE COST FOR THE NECESSARY LABORATORY EQUIPMENT MAY NOT JUSTIFY THE OPERATOR CONDUCTING ALL THESE TESTS. HOWEVER, THE OPERATOR SHOULD PERFORM THE D.O. (DISSOLVED OXYGEN) TEST, THE PH TEST AND THE CHLORINE RESIDUAL TEST IF CHLORINATION IS NECESSARY. THE NECESSITY FOR THESE TESTS TO BE PERFORMED AT THE TIME THEY ARE TAKEN JUSTIFIES THE COST FOR THIS EQUIPMENT. HOWEVER, IN ALL CASES, THE OPERATOR SHOULD BE RESPONSIBLE FOR COLLECTING THE SAMPLES.

THE OPERATOR OF A STABILIZATION POND SYSTEM MAY BE RETAINED ON ONLY A PART-TIME BASIS, WHILE A CONVENTIONAL TREATMENT SYSTEM REQUIRES A FULL-TIME OPERATOR. HOWEVER, IT IS ADVISABLE TO HAVE AT LEAST TWO PERSONS TRAINED IN THE OPERATION OF THE SYSTEM TO ENSURE CONTINUED PROPER OPERATION IN THE EVENT ONE OPERATOR LEAVES FOR ANY REASON.

ADDITIONAL SOURCES OF INFORMATION

CONTROL OF AQUATIC PLANTS IN MINNESOTA
SPECIAL PUBLICATION #39
STATE OF MINNESOTA
DEPARTMENT OF NATURAL RESOURCES
(UNDER REVISION)

FARMER'S BULLETIN 2181
PUBLICATION DIVISION
OFFICE OF INFORMATION
U. S. DEPARTMENT OF AGRICULTURE
WASHINGTON, D. C. 26250

TEXAS MANUAL, CHAPTER 16

SACRAMENTO STATE HOME-STUDY COURSE, CHAPTER 5

NOTE: ADDITIONAL INFORMATION ON MAINTENANCE PROBLEMS CAN BE FOUND IN THE TROUBLE SHOOTING SECTION OF THIS MANUAL.

SECTION G

SAMPLING AND LABORATORY CONTROL TESTS

G-1 GENERAL

MINNESOTA POLLUTION CONTROL AGENCY REGULATIONS REQUIRE THE SUBMISSION OF MONTHLY OPERATION REPORTS ON ALL WASTEWATER TREATMENT FACILITIES. THE REPORTS REQUIRE THE SAMPLING AND TESTING OF THE RAW WASTEWATER, THE TREATED EFFLUENT AND THE RECEIVING STREAM, TO ENSURE PROPER OPERATION.

G-2 PROPER SAMPLING

QUANTITY

GENERALLY, A 2-LITER (SLIGHTLY MORE THAN TWO QUARTS) SAMPLE IS SUFFICIENT FOR MOST PHYSICAL AND CHEMICAL ANALYSES. HOWEVER, IT SHOULD BE NOTED THAT FECAL COLIFORM SAMPLES MUST BE COLLECTED IN SEPARATE STERILIZED BOTTLES.

REPRESENTATIVE SAMPLE

WASTEWATER SAMPLES MUST BE AS NEARLY REPRESENTATIVE OF THE INFLUENT OR EFFLUENT AS POSSIBLE. ERRORS IN SAMPLING PROCEDURES OFTEN NULLIFY THE ACCURACY OF THE LABORATORY TESTS. AS POINTED OUT PREVIOUSLY, THE SAMPLE FOR PHYSICAL AND CHEMICAL ANALYSIS SHOULD BE CONDUCTED WITHIN A 24-HOUR PERIOD AND THE

FECAL COLIFORM TEST SHOULD BE CONDUCTED WITHIN A SIX-HOUR PERIOD.

THE TIME INTERVAL BETWEEN COLLECTION AND ANALYSIS SHOULD BE MINIMIZED AS MUCH AS POSSIBLE. IN SOME INSTANCES WHERE THE TIME ELAPSED BETWEEN COLLECTION AND ANALYSIS WILL BE FOR AN EXTENDED PERIOD OF TIME, THE SAMPLE SHOULD BE REFRIGERATED (OR PACKED IN ICE). HOWEVER, pH, DISSOLVED OXYGEN AND CHLORINE RESIDUAL TESTS SHOULD BE CONDUCTED AT THE TIME OF SAMPLING.

GRAB SAMPLES

GRAB SAMPLES ARE THOSE TAKEN AT ANY ONE TIME FROM ONLY ONE POINT, AND DO NOT REFLECT THE AVERAGE CHARACTERISTICS OF WASTEWATER THROUGH THE DAY.

COMPOSITE SAMPLES

COMPOSITE SAMPLES ARE MADE BY GATHERING INDIVIDUAL SAMPLES AT REGULAR INTERVALS OVER A SELECTED PERIOD OF TIME. THE INDIVIDUAL SAMPLES ARE MIXED TOGETHER PROPORTIONALLY TO THE FLOW AT THE TIME OF SAMPLING. COMPOSITE SAMPLES GENERALLY GIVE MORE MEANINGFUL DATA ON THE WASTEWATER THAN GRAB SAMPLES.

FOR PROPER SAMPLING LOCATIONS OF STABILIZATION PONDS, SEE SECTION E-7 OF THIS MANUAL.

SAMPLING LOCATIONS

SAMPLES OF THE RAW WASTEWATER (INFLUENT) MAY BE OBTAINED IN EITHER THE WET WELL OF THE LIFT STATION (WHICH PUMPS THE

WASTEWATER TO THE PONDS), OR THE INLET MANHOLE OF THE CONTROL STRUCTURE AT THE POND SITE. DO NOT TAKE THE INFLUENT SAMPLE FROM THE WET WELL BASIN AS SOLIDS TEND TO SETTLE OUT IMMEDIATELY UPON ENTERING THE WET WELL. A BUCKET ON A ROPE IS ONE METHOD WHICH MAY BE USED TO COLLECT THIS SAMPLE AS THE WASTEWATER ENTERS THE WET WELL OR STRUCTURE.

EFFLUENT SAMPLES SHOULD BE OBTAINED FROM THE OUTLET CONTROL STRUCTURE AFTER THE DISCHARGE AND DRAWDOWN PROCEDURE HAS BEEN INITIATED. FOR PROPER SAMPLING LOCATIONS PRIOR TO DISCHARGE, REFER TO SECTION E-7 OF THIS MANUAL.

STREAM SAMPLES

THE STREAM SAMPLES WHICH ARE TO BE USED FOR DISSOLVED OXYGEN DETERMINATIONS SHOULD BE COLLECTED AS NEAR AS POSSIBLE TO THE CENTER OF THE FLOW TO BE REPRESENTATIVE OF THE STREAM AND TO AVOID DISTURBING THE STREAM BED. THE UPSTREAM SAMPLE SHOULD BE COLLECTED SOMEWHERE ABOVE THE OUTFALL STRUCTURE OF THE POND. THE DOWNSTREAM SAMPLE SHOULD BE COLLECTED A REASONABLE DISTANCE DOWNSTREAM FROM THE OUTFALL STRUCTURE, GIVING THE EFFLUENT ADEQUATE TIME TO MIX THOROUGHLY INTO THE STREAM.

EQUIPMENT

WHEN COLLECTING THE 24-HOUR COMPOSITE SAMPLE OF THE RAW WASTEWATER, ONE OF THE FOLLOWING METHODS MAY BE USED:

a. BY USING AN AUTOMATIC SAMPLING DEVICE AND COMPOSITING ACCORDING TO THE FLOW AT THE TIME OF SAMPLING.

b. BY TAKING INDIVIDUAL SAMPLES MANUALLY AND THEN COMPOSITING ACCORDING TO THE FLOW AT THE TIME OF SAMPLING.

IN EACH OF THESE PROCEDURES, BE SURE THAT THE WASTEWATER COLLECTED IS THOROUGHLY MIXED TO ASSURE THAT A REPRESENTATIVE SAMPLE IS USED FOR ANALYSIS.

When sampling for coliform the same sampler should never be used if both the raw influent and the effluent samples are to be collected. Contamination from fecal coliforms will result even if the sampler is washed before collecting the pond effluent sample.

SAMPLING FOR DISSOLVED OXYGEN (D.O.) REQUIRES A SPECIAL PROCEDURE AND APPARATUS TO PREVENT THE DISSOLVED OXYGEN CONTENT OF THE SAMPLE TO CHANGE BECAUSE OF CONTACT WITH THE AIR. FURTHER DISCUSSION ON D.O. WILL BE PRESENTED LATER IN THIS SECTION.

CHLORINE RESIDUAL SAMPLING AND TEST

IN SOME CASES, DISINFECTION MAY BE REQUIRED ON THE EFFLUENT FROM STABILIZATION PONDS IN ORDER TO MEET THE FECAL COLIFORM STANDARDS.

DISINFECTION IS A MEANS OF DESTROYING THE ORGAMISMS WHICH ARE CAPABLE OF PRODUCING DISEASE. OZONE, ULTRA-VIOLET LIGHT AND CHLORINE ARE USED AS DISINFECTANTS; HOWEVER, CHLORINE IS THE MOST WIDELY USED AGENT TO DESTROY FECAL COLIFORM ORGAN-

ISMS, MAINLY BECAUSE OF COST AND ACCESSIBILITY FACTORS.

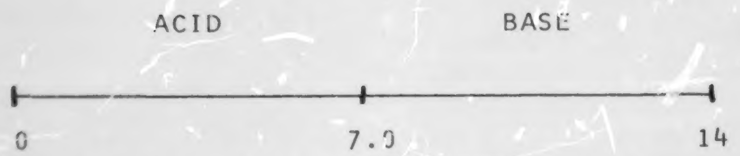
IF YOU ARE REQUIRED TO CHLORINATE YOUR POND EFFLUENT TO MEET THE EFFLUENT STANDARDS YOU MUST RUN A RESIDUAL CHLORINE TEST ON THE EFFLUENT TO DETERMINE IF ADEQUATE CHLORINE IS USED. THIS SAMPLE SHOULD CONSIST OF A GRAB SAMPLE. HOWEVER, THE ANALYSIS SHOULD BE PERFORMED IMMEDIATELY AFTER IT IS COLLECTED.

THIS ANALYSIS MAY BE DONE BY EITHER THE COLORIMETRIC (IODOMETRIC METHOD) OR THE AMPEROMETRIC TITRATION METHOD. THE TEST FOR RESIDUAL CHLORINE MEASURES THE TOTAL EXCESS CHLORINE REMAINING AFTER A SPECIFIED CONTACT PERIOD. THE GENERAL "RULE OF THUMB" IS TO HAVE A 0.5 MG/L RESIDUAL AFTER A CONTACT PERIOD OF 15 MINUTES. HOWEVER, THE AMOUNT OF RESIDUAL REQUIRED AFTER 15 MINUTES SHOULD BE SUBSTANTIATED ON THE BASIS OF THE TEST FOR FECAL COLIFORMS AND COMPLIANCE WITH THE EFFLUENT STANDARDS.

G-3 TESTS TO BE CONDUCTED

pH

pH IS A NUMERICAL EXPRESSION OF THE INTENSITY OF THE ACIDITY OR ALKALINITY. THE NUMBERS 0 TO 14 ARE USED TO EXPRESS pH VALUES. THE pH VALUE OF 7.0 IS THE NEUTRAL POINT WHICH IS NEITHER ACID NOR ALKALINE. A NUMBER BELOW 7.0 DENOTES ACIDITY, A NUMBER ABOVE 7.0 INDICATES ALKALINITY, WITH THE INTENSITY INCREASING AS THE NUMBERS INCREASE, OR DECREASE FROM 7.0.



THE METHODS USED TO DETERMINE THE pH ARE THE COLORIMETRIC COMPARATOR, AND pH METER. HOWEVER, THE PREFERRED METHOD IS THE GLASS ELECTRODE pH METER. AS WE HAVE PREVIOUSLY POINTED OUT, THE pH TEST MUST BE CONDUCTED AT THE TIME OF SAMPLING.

SUSPENDED SOLIDS

NORMAL DOMESTIC WASTEWATER WILL USUALLY CONTAIN BETWEEN 250 AND 300 MILLIGRAMS PER LITER OF SUSPENDED SOLIDS.

THE SUSPENDED SOLIDS IN WASTEWATER CONSTITUTE THAT FRACTION OF SOLIDS WHICH ARE INSOLUBLE. THESE SOLID PARTICLES VARY IN SIZE, SOME BEING LARGE AND HEAVY, AND TEND TO SETTLE READILY UNDER QUIESCENT CONDITIONS; OTHER SMALLER PARTICLES TEND TO SETTLE SLOWLY OR NOT AT ALL UNDER THE ACTION OF GRAVITY.

THE SUSPENDED SOLIDS TEST IS CONDUCTED BY FILTERING A QUANTITY OF WASTEWATER THROUGH A GLASS FIBER FILTER AND WEIGHING THE AMOUNT OF MATERIAL DEPOSITED ON THE FILTER. THE SUSPENDED SOLIDS ARE REPORTED IN MILLIGRAMS PER LITER.

FECAL COLIFORM ORGANISMS

THE FECAL COLIFORM GROUP ORGANISMS INCLUDE ONLY THAT SPECIES WHICH IS PREDOMINANTLY DERIVED FROM THE GUT OF WARM-BLOODED ANIMALS AND IS, THUS, A BETTER INDICATION OF FECAL

CONTAMINATION THAN THE TOTAL COLIFORM GROUP. SINCE WATER-BORNE PATHOGENS ARE ASSOCIATED WITH FECAL CONTAMINATION, A FECAL COLIFORM EXAMINATION PROVIDES A MORE DIRECT EVIDENCE OF THE POSSIBILITY OF THE PRESENCE OF PATHOGENS.

THE FECAL COLIFORM CONCENTRATIONS FROM STABILIZATION POND EFFLUENTS (UNCHLORINATED) CAN BE DETERMINED BY THE MEMBRANE FILTER TECHNIQUE. THIS IS ACCOMPLISHED BY FILTERING A QUANTITY OF WASTEWATER THROUGH A MEMBRANE FILTER AND INCUBATING IN A SPECIAL MEDIA IN A WATER BATH FOR 24 HOURS.

FECAL COLIFORM ORGANISMS ARE REPORTED AS THE MOST PROBABLE NUMBER OF FECAL COLIFORMS PER 100 MILLILITERS.

BIOCHEMICAL OXYGEN DEMAND

THE BIOCHEMICAL OXYGEN DEMAND (BOD) TEST PROVIDES A QUANTITATIVE MEASURE OF THE DISSOLVED OXYGEN (D.O.) REQUIRED TO MAINTAIN THE GROWTH AND ACTIVITIES OF THE BIOLOGICAL ORGANISMS RESPONSIBLE FOR DECOMPOSING THE ORGANIC AND PUTRESCIBLE MATTER IN SEWAGE AT A SPECIFIED TEMPERATURE AND FOR A DESIGNATED PERIOD OF TIME. THE ACCEPTED STANDARD TEST PERIOD IS A FIVE-DAY INCUBATION PERIOD AT 20 CENTIGRADE DEGREES. THE BOD IS THEN CALCULATED ON THE BASIS OF THE REDUCTION OF THE D.O. AND THE SIZE OF THE SAMPLE USED.

NORMAL DOMESTIC WASTEWATER PRIOR TO TREATMENT WILL USUALLY CONTAIN BETWEEN 200 AND 250 MILLIGRAMS PER LITER OF FIVE-DAY BOD.

DISSOLVED OXYGEN (D.O.)

THIS REPRESENTS THE OXYGEN DISSOLVED IN THE WATER. THE DISSOLVED OXYGEN IS DERIVED DIRECTLY FROM THE SURROUNDING AIR AND FROM THE OXYGEN GIVEN OFF FROM AQUATIC PLANTS DURING THE PROCESS OF PHOTOSYNTHESIS. A TABLE SHOWING THE SOLUBILITY OF OXYGEN IN FRESH WATER IS SHOWN IN FIGURE 17.

DISSOLVED OXYGEN CAN BE DETERMINED BY ONE OF THE FOLLOWING PROCEDURES:

a. A DISSOLVED OXYGEN METER.

b. THE "WINKLER" WET CHEMISTRY METHOD.

c DISSOLVED OXYGEN TEST KITS WHICH ARE MODIFICATIONS OF THE "WINKLER METHOD."

THE FOLLOWING IS AN INEXPENSIVE METHOD FOR DETERMINING DISSOLVED OXYGEN, WHICH IS A MODIFICATION OF THE "WINKLER METHOD." (HACH METHOD)

1) ADD MANGANOUS SULFATE - NO. 1 PILLOW.

2) ADD ALKALINE-IODIDE-AZIDE - NO. 2 PILLOW.

3) STOPPER BOTTLE WITH CARE TO EXCLUDE AIR BUBBLES AND MIX BY INVERTING THE BOTTLE ABOUT TEN TIMES (OR 20 SECONDS).

4) ALLOW THE PRECIPITATE TO SETTLE TO SHOULDER OF BOTTLE , AND CAREFULLY REMOVE THE STOPPER AND IMMEDIATELY ADD SULFURIC ACID - NO. 3 PILLOW.

5) RESTOPPER THE BOTTLE AND MIX BY GENTLE INVERSION UNTIL DISSOLUTION IS COMPLETE, NOTE: THIS IS A

(HACH METHOD - CON'T)

BIT TRICKY TO STOPPER THE BOTTLE WITHOUT GETTING AN AIR BUBBLE TRAPPED IN BOTTLE, IF AN AIR BUBBLE IS TRAPPED, DISCARD SAMPLE AND START OVER.

6) POUR INTO A MEASURING TUBE LEVEL FULL AND TRANSFER TO MIXING BOTTLE.

7) TITRATE SAMPLE IN MIXING BOTTLE WITH PHENYLARSINE OXIDE (PAO) TO A STRAW COLOR.

8) ADD TWO MILLILITERS OF STARCH SOLUTION AND CONTINUE TO THE FIRST DISAPPEARANCE OF BLUE COLOR. COMPUTATION: DISSOLVED OXYGEN IN MG/L IS EQUAL TO THE NUMBER OF DROPS OF PAO USED IN THE TITRATION.

starch indicator is not provided with this kit. If you need this, please contact the MPCA for instructions on how to prepare it.

also, it should be noted that under NPDES regulations, the D.O. test kits ***cannot*** *be used for BOD determinations.*

TOTAL PHOSPHORUS

TOTAL PHOSPHORUS INCLUDES ALL AVAILABLE AND UNAVAILABLE, PHOSPHORUS WHICH IS IN THE SAMPLED WASTEWATER, INCLUDING BOTH ORGANIC AND INORGANIC FORMS.

SOLUBILITY OF OXYGEN IN FRESH WATER

°C	°F	O_2 (PPM)	°C	°F	O_2 (PPM)
0	32.0	14.6	26	78.8	8.2
1	33.8	14.1	27	80.6	8.1
2	35.6	13.8	28	82.4	7.9
3	37.4	13.5	29	84.2	7.9
4	39.2	13.1	30	86.0	7.6
5	41.0	12.8	31	87.8	7.5
6	42.8	12.5	32	39.6	7.4
7	44.6	12.2	33	91.4	7.3
8	40.4	11.9	34	93.2	7.2
9	48.2	11.6	35	95.0	7.1
10	50.0	11.3	36	96.8	7.0
11	51.8	11.1	37	98.6	6.9
12	53.6	10.8	38	100.4	6.8
13	55.4	10.6	39	102.2	6.7
14	57.1	10.4	40	104.0	6.6
15	59.0	10.2	41	105.8	6.5
16	60.8	10.0	42	107.6	6.4
17	62.6	9.7	43	109.4	6.3
18	64.4	9.5	44	111.2	6.2
19	66.2	9.4	45	113.0	6.1
20	68.0	9.2	46	114.8	6.0
21	69.8	9.0	47	116.6	5.9
22	71.6	8.8	48	118.4	5.8
23	73.4	8.7	49	120.2	5.7
24	75.2	8.5	50	122.0	5.6
25	77.0	8.4	51	123.8	5.5

FIGURE 17

KJELDAHL NITROGEN

KJELDAHL NITROGEN INCLUDES THE ORGANIC NITROGEN CONTENT OF THE PRODUCTS OF BIOLOGIC PROCESSES AND ALSO INCLUDES AMMONIA NITROGEN. THIS IS KNOWN AS TOTAL KJELDAHL NITROGEN.

The above two tests (Total Phosphorus and Kjeldahl Nitrogen) are required of only those effluents which are discharged to lakes or reservoirs. The reason being that these elements are considered primary food elements for algae growth.

G-4 FREQUENCY OF TESTS

THE EQUIPMENT REQUIRED TO PERFORM THE REQUIRED ANALYTICAL TESTS IS **USUALLY** NOT PROVIDED WITH THE CONSTRUCTION OF STABILIZATION PONDS BECAUSE IT WOULD BE QUITE COSTLY TO PROVIDE AN EXTENSIVE LABORATORY FACILITY.

IN SOME CASES, THE COMMUNITY MAY HAVE LABORATORY FACILITIES IN WHICH THE ANALYSES COULD BE PERFORMED IF THE EQUIPMENT NECESSARY FOR THESE TESTS WAS PURCHASED.

A PRIVATE TESTING FIRM MAY BE RETAINED OR ARRANGEMENTS WITH A NEIGHBORING COMMUNITY WHICH HAS LABORATORY FACILITIES MAY BE MADE FOR CONDUCTING THESE REQUIRED TESTS.

HOWEVER, THE OPERATOR SHOULD BE RESPONSIBLE FOR THE COLLECTION OF THE SAMPLES AND SHOULD CONDUCT THE pH, D.O. AND CHLORINE RESIDUAL TESTS, AND THESE TESTS MUST BE PERFORMED AT THE TIME THEY ARE COLLECTED.

A COMPLETE LIST OF THE FREQUENCY OF TESTS AND OBSERVATIONS WHICH MUST BE CONDUCTED IS INCLUDED IN APPENDIX E.

ADDITIONAL SOURCES OF INFORMATION

- STANDARD METHODS FOR THE EXAMINATION OF WATER AND WASTEWATER.
- SIMPLIFIED LABORATORY PROCEDURES FOR WASTEWATER EXAMINATION, MOP #18, WPCF.
- LABORATORY PROCEDURE FOR WASTEWATER TREATMENT PLANT OPERATORS, NEW YORK.
- TEXAS MANUAL, CHAPTER 28.
- SELF-MONITORING PROCEDURES: BASIC PARAMETERS FOR MUNICIPAL EFFLUENTS, U.S. EPA
- MANUAL OF METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTES, U.S. EPA

SECTION H

RECORDS AND REPORTS

H-1 GENERAL

FORMS, REPORTS AND RECORDS SHOULD BE KEPT BY THE OPERATOR TO BE USED AS REFERENCE MATERIAL. ACCURATE RECORDS ARE AN INVALUABLE AID FOR COMPLETE EVALUATION OF TREATMENT FACILTIES. A COMPLETE SET OF AS-BUILT DRAWINGS OF THE FACILITY SHOULD BE AVAILABLE TO THE OPERATOR AND ANY CHANGES THAT ARE MADE, SUCH AS PIPING AND ELECTRICAL CHANGES, SHOULD BE RECORDED AND INCLUDED ON THESE DRAWINGS.

H-2 MAINTENANCE RECORDS

IT IS IMPERATIVE THAT RECORDS BE KEPT OF THE SERVICE REQUIREMENTS OF ALL EQUIPMENT IN THE TREATMENT FACILITY. THEREFORE, A SYSTEM IS NEEDED TO KEEP A RECORD OF MAINTENANCE. SUCH A SYSTEM SHOULD PROVIDE A PERMANENT RECORD OF ALL MAINTENANCE WORK COMPLETED ALONG WITH PREVENTIVE MAINTENANCE SCHEDULES. TO BE EFFICIENT, A FILE AND/OR LOG BOOK SHOULD BE SET UP WHICH CONTAINS THE FOLLOWING INFORMATION:

1) PREVENTIVE MAINTENANCE RECORDS.
2) THE PREVENTIVE MAINTENANCE SCHEDULE.
3) SERVICE RECORD CARDS.
4) WHERE SPARE PARTS CAN BE PURCHASED.

5) SPARE PARTS INVENTORY.

6) OPERATION AND MAINTENANCE INSTRUCTIONS.

7) SPECIFICATIONS ON EQUIPMENT FROM SUPPLIER.

8) EQUIPMENT INVENTORY.

H-3 OPERATING RECORDS

RECORDS SHOULD BE MAINTAINED WHICH INDICATE THE AMOUNT OF TIME SPENT FOR OPERATION. THIS RECORD SHEET MAY CONTAIN AS MUCH INFORMATION AS, YOU, THE OPERATOR, FEEL NECESSARY TO MAINTAIN. THESE OPERATION RECORDS MAY PROVIDE INFORMATION FOR PERFORMANCE EVALUATION AND INDICATE VALUABLE INFORMATION IN HANDLING CERTAIN SITUATIONS WITHIN THE TREATMENT WORKS.

H-4 MONTHLY REPORTS

THE REQUIRED MONTHLY REPORTS SHOULD BE COMPLETED AND SUBMITTED TO THE MINNESOTA POLLUTION CONTROL AGENCY. A COPY OF THESE REPORTS SHOULD ALWAYS BE RETAINED BY THE OPERATOR FOR HIS RECORDS, AS A COMPLETE SET OF RECORDS WILL PROVIDE THE BASIS FOR FUTURE DESIGN IF EXPANSION IS NEEDED AS WELL AS SERVE AS A LEGAL RECORD OF OPERATION

A sample copy of these forms and a guide for completion of MPCA Form 704 is attached as appendix E.

H-5 OPERATION AND MAINTENANCE COST RECORDS

A COMPLETE RECORD SHOULD BE KEPT OF ELECTRICAL CHARGES, COST OF REPLACEMENT PARTS, LUBRICANT COSTS, ETC. THESE RECORDS WILL PROVIDE THE BASIS OF ESTIMATING FUNDING REQUIREMENTS, SEWER CHARGES AND YEARLY BUDGETS.

H-6 MAINTENANCE FORMS

COMPLETE RECORDS SHOULD BE KEPT OF ALL MAINTENANCE DUTIES AND FREQUENCY OF PERFORMANCE. THESE RECORDS ARE VERY VALUABLE IN PREPARING WORK AND MAINTENANCE SCHEDULES.

Sample Maintenance Forms are Shown in the following figures 18 and 19

WASTEWATER TREATMENT PLANT
EQUIPMENT MAINTENANCE RECORD

Equipment Nomenclature		Serial Number
Manufacturer	Location	Attachments Page # 1. 2. 3.

Modification and Repair

Date	Description of Work Performed	Parts,New or Repaired	Man Hours	By

FIGURE 18

Equipment Nomenclature	Serial Number
Manufacturer	Inst. Date
Location	
Lubricants	
Preventive Maintenance Schedule	Frequency

PREVENTIVE MAINTENANCE CARD

FIGURE 13

SECTION I

PUBLIC HEALTH ASPECTS

I-1 PUBLIC HEALTH ASPECTS

STABILIZATION PONDS, LIKE OTHER WASTEWATER TREATMENT FACILITIES, MUST BE TREATED WITH CAUTION AND RESPECT FROM A SAFETY AND PUBLIC HEALTH STANDPOINT BY OPERATORS AND THE GENERAL PUBLIC ALIKE. THIS MEANS THAT STABILIZATION PONDS MUST BE UTILIZED FOR THEIR DESIGNED PURPOSE ONLY, AND NOT FOR PUBLIC RECREATION.

THE RELATIVE AREA OF WATER SURFACE OF STABILIZATION PONDS IS INSIGNIFICANT IN COMPARISON TO THE MANY NATURAL BODIES OF OPEN WATER IN MOST AREAS. IN SOME AREAS, HOWEVER, STABILIZATION PONDS REPRESENT THE ONLY SIZEABLE AREA OF OPEN WATER AND HAVE BEEN SOURCES OF ATTRACTION TO CHILDREN AS WELL AS ADULTS FOR RECREATION PURPOSES. INCIDENTS OF BOATING, ICE-SKATING, EXTENSIVE WATERFOWL HUNTING AND EVEN SWIMMING IN PONDS HAVE BEEN REPORTED. THIS RECREATIONAL USE MUST BE DISCOURAGED AND SAFETY PRACTICES ENCOURAGED FOR SEVERAL IMPORTANT REASONS.

FIRST, EVEN THOUGH THE EFFICIENCY OF BACTERIAL REMOVAL AS MEASURED BY THE MPN METHOD IS VERY HIGH, THE POSSIBILITY OF CONTAMINATION OR INFECTION FROM PATHOGENIC ORGANISMS DOES EXIST WHEN ONE COMES IN CONTACT WITH WASTEWATER IN A STABILIZATION POND.

SECOND, ALTHOUGH MOST STABILIZATION PONDS ATTAIN A DEPTH OF ONLY FIVE FEET, THERE IS STILL SUFFICIENT DEPTH TO DROWN A PERSON. ALSO, THE CLAY LINER USED IN SEALING THE POND BECOMES VERY STICKY WHEN WATER IS ADDED. SHOULD ANYONE FALL IN THE POND, THIS CLAY LINER WOULD MAKE IT EXTREMELY DIFFICULT FOR ANYONE TO GET OUT.

ONE NATURAL FACTOR WHICH DISCOURAGES THE USE OF STABILIZATION PONDS FOR RECREATIONAL PURPOSES IS THE MOSQUIT; HOWEVER, ON A WELL MAINTAINED POND SYSTEM, MOSQUITOES USUALLY DO NOT CAUSE ANY NUISANCE.

ACCORDING TO STUDIES MADE BY THE U. S. PUBLIC HEALTH SERVICE, THE DENSITY OF MOSQUITO POPULATION IS DIRECTLY PROPORTIONAL TO THE EXTENT OF WEED GROWTH IN THE PONDS. WHERE WEED BROWTH IN THE PONDS AND ALONG THE WATER LINE OF THE DIKES IS NEGLIGIBLE AND WHERE WIND ACTION ON THE POND IS NOT UNDULY RESTRICTED, THE PRODUCTION OF MOSQUITOES IN STABILIZATION PONDS IS OF LITTLE CONSEQUENCE.

I-2 PERSONAL HYGIENE

IT IS IN THE INTEREST OF YOUR HEALTH AND THE HEALTH OF YOUR FAMILY THAT THIS LIST OF DO'S AND DON'TS FOR PERSONAL HYGIENE IS MADE. USE, IT DON'T ABUSE IT!

1. NEVER EAT YOUR LUNCH OR PUT ANYTHING INTO YOUR MOUTH WITHOUT FIRST WASHING YOUR HANDS.

2. REFRAIN FROM SMOKING WHILE WORKING IN TANKS, ON PUMPS, TRUCKS, FILTERS ETC. REMEMBER, YOU INHALE OR INGEST THE FILTH THAT COLLECTS ON THE CIGARETTE FROM DIRTY HANDS. SAVE YOUR SMOKING TIME FOR LUNCH HOURS OR AT HOME.

3. A GOOD POLICY IS NEVER PUT YOUR HANDS ABOVE YOUR COLLAR WHEN WORKING ON ANY PLANT EQUIPMENT.

4. DON'T WEAR YOUR WORK COVERALLS OR RUBBER BOOTS TO THE DINING AREA.

5. ALWAYS WEAR YOUR RUBBER BOOTS WHEN WORKING IN TANKS, AROUND SLUDGE, WASHING DOWN ETC. DON'T WEAR YOUR STREET SHOES.

6. KEEP YOUR STREET SHOES IN YOUR LOCKER, REMEMBER THAT WHAT YOUR SHOES PICK UP AT THE PLANT THEY WILL LEAVE ON THE FLOOR OF YOUR HOME.

7. DON'T WEAR YOUR COVERALLS OR RUBBER BOOTS IN YOUR CAR OR HOME.

8. ALWAYS CLEAN ANY EQUIPMENT SUCH AS SAFETY BELTS, HARNESS, FACE MASKS, GLOVES, ETC., AFTER USING. YOU OR SOMEONE MAY WANT TO USE IT AGAIN.

9. HAVE A COMPLETE CHANGE OF CLOTHING TO WEAR WHEN GOING HOME.

10. ALWAYS WEAR RUBBER OR PLASTIC COATED GLOVES WHEN CLEANING OUT PUMPS, HANDLING HOSES OR WHEN WORKING ANYWHERE AROUND THE PLANT.

11. AVOID PUTTING ON WORK GLOVES WHEN YOUR HANDS ARE DIRTY - WASH FIRST.

12. WASH WITH PLENTY OF WATER OR TAKE A SHOWER IMMEDIATELY AFTER BEING SPLASHED WITH SLUDGE OR ANY CHEMICAL - DON'T DELAY.

13. DON'T JUST WASH YOUR HANDS BEFORE GOING HOME, WASH YOUR FACE THOROUGHLY TOO.

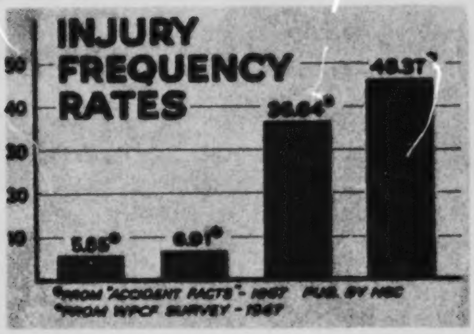
14. WEAR A HARD HAT WHEN WORKING AROUND MANHOLES OR LIFT STATIONS.

15. KEEP YOUR FINGERNAILS CUT SHORT AND CLEAN AS THEY ARE EXCELLENT CARRYING PLACES FOR DIRT AND GERMS.

I-3 SAFETY

THIS MANUAL WOULD NOT BE COMPLETE UNLESS SOMETHING WAS SAID ABOUT SAFETY.

THE WASTEWATER AND POLLUTION CONTROL INDUSTRY HAS THE HIGHEST EMPLOYEE ACCIDENT RATE OF ALL INDUSTRIES IN THE UNITED STATES. A 1967 WATER POLLUTION CONTROL FEDERATION SURVEY SHOWED THAT WASTEWATER SYSTEMS HAD AN INJURY RATE NEARLY EIGHT TIMES THAT OF THE GAS UTILITY INDUSTRY WHICH HAS MOST OF THE SAME HAZARDS. THE INJURY RATE FOR WASTEWATER SYSTEMS WAS OVER SIX AND ONE-HALF TIMES THAT OF THE AVERAGE INDUSTRY, AND NEARLY 25 PERCENT MORE THAN THAT OF THE VERY WORST AMONG THE INDUSTRIES REPORTING TO THE NATIONAL SAFETY COUNCIL !



WE WILL ATTEMPT TO BRIEFLY OUTLINE SOME IMPORTANT SAFETY RULES WHICH SHOULD BE FOLLOWED BY A WASTEWATER TREATMENT FACILITY OPERATOR.

A. SEWER MAINTENANCE SAFETY PRECAUTIONS.

1. REMOVE AND REPLACE HEAVY MANHOLE COVERS CAREFUULY AND ONLY WITH THE PROPER TOOLS. AFTER REMOVAL, LAY THE COVER FLAT ON THE GROUND AT LEAST TWO FEET AWAY FROM THE OPEN MANHOLE.
2. DESCEND INTO ANY MANHOLE CAUTIOUSLY TO GUARD AGAINST SLIPPERY, LOOSE, CORRODED, BROKEN OR OTHERWISE DEFECTIVE STEPS OR RUNGS. REMEDY SUCH DEFECTS IMMEDIATELY, TOGETHER WITH ANY CRACKS OR BREAKS IN THE MANHOLE WALL.
3. WEAR AN APPROVED TESTED SAFETY BELT WITH ATTACHED LIFELINE WHEN ENTERING A SEWER DEEPER THAN 8 FEET. AT LEAST TWO MEN SHOULD STAND BY OUTSIDE THE MAN-

HOLE TO HANDLE THE LIFELINE IN CASE OF EMERGENCY. EXTRA LENGTHS OF ROPE MUST BE READILY AVAILABLE.

4. ASSIGN A TRAINED PERSON TO SUPERVISE THE CLEANING AND MAINTENANCE OF SEWERS AND ALERT ALL OTHER PERSONNEL TO POSSIBLE HAZARDS AND TO PRECAUTIONS AGAINST THEM.

5. ERECT BARRIERS AND SIGNS AT A SUITABLE DISTANCE FROM OPEN MANHOLES TO ALERT TRAFFIC COMING FROM ANY DIRECTION THAT MEN ARE AT WORK.

B. PUMPING STATION AND STABILIZATION POND SAFETY PRECAUTIONS.

1. MAINTAIN A HIGH LEVEL OF GOOD HOUSEKEEPING. THIS INVOLVES KEEPING FLOORS, WALLS AND EQUIPMENT FREE FROM DIRT, GREASE AND DEBRIS. KEEP TOOLS PROPERLY STORED WHEN NOT IN USE. MAKE MINOR REPAIRS TO STRUCTURES AND APPURTENANCES IMMEDIATELY TO AVOID FURTHER DAMAGE AND POSSIBLE ACCIDENTS.

2. KEEP WALKWAYS CLEAN AND FREE FROM SLIPPERY SUBSTANCES. IF ICE FORMS ON WALKS, APPLY SALT OR SAND OR COVER WITH EARTH OR ASHES THAT CAN BE REMOVED LATER.

3. BE ESPECIALLY CAUTIOUS WHEN WORKING WITH AN ELECTRICAL DISTRIBUTION SYSTEM AND RELATED FACILITIES. NEVER WORK ON ELECTRICAL EQUIPMENT AND WIRE WITH WET HANDS OR WHEN CLOTHES OR SHOES ARE WET. ALWAYS WEAR APPRO-

PRIATE SAFETY GLOVES FOR ELECTRICAL WORK. NEVER USE A SWITCHBOX FOR ANYTHING OTHER THAN A SWITCHBOX.

4. KEEP ALL PERSONNEL SAFETY CONSCIOUS BY REMINDING THEM OF SPECIFIC SAFETY INSTRUCTIONS. SUCH INSTRUCTIONS SHOULD INCLUDE INFORMATION ON HOW TO CONTACT THE NEAREST MEDICAL CENTER AND FIRE STATION, RESCUE TECHNIQUES, RESUSCITATION AND FIRST AID TECHNIQUES.
5. MAKE CERTAIN THAT A SUFFICIENT NUMBER OF CAPABLE PERSONNEL WITH PROPER EQUIPMENT ARE ASSIGNED AND PRESENT WHENEVER IT IS NECESSARY TO PERFORM ANY HAZARDOUS WORK.
6. A LIFE PRESERVER MUST BE USED WHEN USING A BOAT ON STABILIZATION PONDS. ALSO, NEVER WORK ALONE AROUND THE PONDS TO PREVENT DROWNING AND OTHER ACCIDENTS. ONE OF THE REQUIREMENTS FOR A POND OPERATOR SHOULD BE THAT HE CAN SWIM AT LEAST 100 FEET IN NORMAL WORK CLOTHING.
7. WARNING SIGNS SHOULD BE INSTALLED NEAR DANGEROUS MACHINERY OR AT ANY LOCATION INVOLVING A STUMBLING HAZARD. THE SIGNS SHOULD BE DESIGNED AND LOCATED TO CALL ATTENTION TO A SPECIFIC DANGER AND DISCRETION MUST BE USED IN DETERMINING THE NUMBER AND PLACEMENT OF SIGNS SO PERSONNEL WILL PAY MAXIMUM ATTENTION TO THEM.
8. SUFFICIENT FIRE EXTINGUISHERS (UNDERWRITER'S LABORATORIES APPROVED) SHOULD BE PLACED IN READILY ACCESSIBLE

LOCATIONS.

C. BODY INFECTION AND DISEASE SAFETY PRECAUTIONS.

1. TREAT ALL CUTS, SKIN ABRASIONS AND SIMILAR INJURIES PROMPTLY. WHEN WORKING WITH WASTEWATER, THE SMALLEST CUT OR SCRATCH IS POTENTIALLY DANGEROUS AND SHOULD BE CLEANED AND TREATED IMMEDIATELY WITH A 2% SOLUTION OF TINCTURE OF IODINE.
2. SEE A DOCTOR FOR ALL INJURIES.
3. PROVIDE FIRST AID TRAINING FOR ALL PERSONNEL.
4. BE INNOCULATED FOR WATERBORNE DISEASES, PARTICULARLY TYPHOID AND PARATYPHOID FEVER. KEEP A RECORD OF ALL IMMUNIZATIONS IN AN EMPLOYEE HEALTH RECORD TO ASSURE YOURSELF OF RECEIVING UP TO DATE BOOSTERS, ETC.
5. KEEP FINGERS OUT OF NOSE, EYES AND MOUTH BECAUSE THE HANDS CARRY MOST INFECTIONS IN THIS FIELD OF WORK.
6. AFTER WORK, BEFORE EATING AND AT OTHER CONVENIENT TIMES, WASH HANDS THOROUGHLY WITH PLENTY OF SOAP AND HOT WATER. KEEP FINGERNAILS SHORT AND REMOVE ALL DIRT AS OFTEN AS POSSIBLE WITH A NAIL FILE, OR A STIFF, SOAPY BRUSH.
7. IN LABORATORY WORK, USE PIPET BULBS RATHER THAN THE MOUTH SO AS NOT TO INTRODUCE CONTAMINATION TO THE MOUTH. DON'T DRINK WATER FROM LABORATORY GLASSWARE. PAPER CUPS SHOULD BE PROVIDED IN LABORATORIES FOR

DRINKING PURPOSES. NEVER PREPARE FOOD IN A LABORATORY.

8. KEEP HANDS OUT OF WASTEWATER, SLUDGE OR GRIT AS MUCH AS POSSIBLE. WHEN SUCH CONTACT IS UNAVOIDABLE, WEAR RUBBER GLOVES.

9. EMERGENCY FIRST AID KITS TO TREAT ANY MINOR ON THE JOB INJURY SHOULD BE READILY ACCESSIBLE.

10 RUBBER GLOVES SHOULD BE USED WHEN CLEANING CLOGGED PUMPS, PIPES AND IN CLEANING THE WET WELL. SUCH PROTECTION IS PARTICULARLY IMPORTANT WHEN THE SURFACE OF THE SKIN IS BROKEN OR IRRITATED.

11. COVERALLS OR A COMPLETE CHANGE OF CLOTHES FOR WORKING HOURS SHOULD BE USED. BOOTS AND RUBBERS SHOULD BE USED TO KEEP FEET CLEAN AND DRY WHEN IN CONTACT WITH WASTEWATER.

D. NOXIOUS GASES, EXPLOSIVE MIXTURES AND OXYGEN DEFICIENCY.

1. SEWER GAS. THE PRINCIPAL GAS HAZARDS ASSOCIATED WITH WASTEWATER TREATMENT ARE ACCUMULATIONS OF SEWER GAS AND ITS MIXTURE WITH OTHER GASES OR AIR WHICH MAY CAUSE DEATH OR INJURY THROUGH EXPLOSION OR BY ASPHYXIATION AS A RESULT OF OXYGEN DEFICIENCY. THE TERM SEWER GAS IS GENERALLY APPLIED TO THE MIXTURE OF GASES IN SEWERS AND MANHOLES CONTAINING HIGH PERCENTAGES OF CARBON DIOXIDE, VARYING AMOUNTS OF METHANE, HYDROGEN, HYDROGEN SULFIDE AND LOW PERCENTAGES OF OXYGEN. SUCH

MIXTURES SOMETIMES ACCUMULATE IN SEWERS AND MANHOLES WHERE ORGANIC MATTER HAS BEEN DEPOSITED AND HAS UNDERGONE DECOMPOSITION. THE ACTUAL HAZARDS FROM SEWER GAS EXIST IN THE EXPLOSIVE AMOUNT OF METHANE OR IN OXYGEN DEFICIENCY.

2. CHLORINE. CHLORINE GAS, WHICH IS IRRITATING TO THE EYES, RESPIRATORY TRACT AND OTHER MUCOUS MEMBRANES, MAY SETTLE IN LOW, STILL AREAS. THE GAS ESCAPES BY LEAKAGE FROM CYLINDERS AND FEED LINES AND FINDS ITS WAY TO THESE PLACES.

SAFETY PRECAUTIONS TO FOLLOW IN SITUATIONS WHERE THE PRESENCE OF GAS IS POSSIBLE SHOULD INCLUDE:

1. PROHIBIT SMOKING AND OPEN FLAMES IN AND AROUND OPEN MANHOLES, SEWERS AND WETWELLS, AS GASOLINE OR PETROLEUM VAPORS , ILLUMINATING GAS AND METHANE ARE COMMON IN THESE AREAS. USE ONLY PERMISSIBLE EXPLOSION PROOF LIGHTS, ELECTICAL FIXTURES, MOTORS AND OTHER EQUIPMENT IN ALL SUCH DANGEROUS AREAS.
2. MAKE PERIODIC CHECKS FOR GAS LEAKS IN CHLORINE ROOMS TO PRECLUDE ACCIDENTS.
3. VENTILATION SHOULD BE PROVIDED WHEN ENTERING WET WELLS, LIFT STATIONS, CHLORINE ROOMS AND MANHOLES.
4. USE OXYGEN DEFICIENCY INDICATORS AND HAVE GAS MASKS WITH AN O_2 SUPPLY ON HAND WHEN WORKING IN ANY LOCATION THAT HAS A POTENTIAL GAS HAZARD.

5. USE EXTREME CAUTION WHEN HANDLING CHLORINE. THE TEST FOR A CHLORINE LEAK IS TO SOAK A RAG IN AMMONIA AND HOLD IT IN THE AREA OF A SUSPECTED LEAK. IF A LEAK HAS OCCURRED, A WHITE CLOUD WILL EMINATE FROM THE AMMONIA SOAKED RAG.

I-4 SAFETY EQUIPMENT

THE TYPES OF SAFETY EQUIPMENT WHICH A WASTEWATER FACILITY SHOULD HAVE ARE AS FOLLOWS:

1. DETECTION EQUIPMENT (FOR GASES AND OXYGEN DEFICIENCIES).
2. MASKS (SELF CONTAINED AIR PACKS FOR OXYGEN DEFICIENCIES).
3. SAFETY HARNESSES, LINES AND HOISTS.
4. PROPER PROTECTIVE CLOTHING, FOOTWEAR, AND HEAD GEAR.
5. VENTILATING EQUIPMENT.
6. NON-SPARKING TOOLS.
7. COMMUNICATIONS EQUIPMENT.
8. PORTABLE AIR BLOWER.
9. EXPLOSION-PROOF LANTERN AND OTHER SAFE ILLUMINATION.
10. WARNING SIGNS AND BARRIERS.
11. EMERGENCY FIRST AID KITS.
12. PROPER FIRE EXTINGUISHERS.
13. EYE WASH AND SHOWER STATIONS IN LABORATORY AREAS.
14. SAFETY GOGGLES FOR WORK IN LABORATORIES AND OTHER DANGEROUS AREAS.

ADDITIONAL SOURCES OF INFORMATION

- NEW YORK MANUAL, CHAPTER 14
- WPCF, MOP #1, SAFETY IN WASTEWATER WORKS
- TEXAS MANUAL, CHAPTER 35
- SACRAMENTO STATE HOME-STUDY COURSE, CHAPTER 12.

GLOSSARY OF WASTEWATER TERMS

APPENDIX "A"

ABSORPTION:	the taking up of one substance into the body of another by chemical or molecular action.
ACRE-FOOT:	a volume term referring to that amount of liquid, 1 acre in area one foot deep. (43,560 cubic feet).
ADSORPTION:	the taking up of substance upon the surface or onto the interface zone of another.
AERATED POND:	a wastewater treatment pond in which mechanical or diffused-air aeration is used to supplement the oxygen supply.
AEROBIC:	a condition characterized by the presence of free dissolved oxygen in the aquatic environment.
AEROBIC BACTERIA:	bacteria that require free dissolved oxygen for growth.
AEROBIC DECOMPOSITION:	the breakdown of complex organic matter by bacteria in the presence of dissolved oxygen.
ALGAE:	primitive one or many-celled plants, usually aquatic, that produce their food by photosynthesis.
ALGAL BLOOM:	large masses of microscopic and macroscopic plant-life, such as green algae, occurring in bodies of water.
ALGICIDE:	any substance or chemical applied to kill or control algal growths.
AMPEROMETRIC TITRATION:	an electrometric method of detecting the end point in a chlorine residual determination.
ANAEROBIC:	the condition in which dissolved oxygen is undetectable in the aquatic environment.
ANAEROBIC BACTERIA:	bacteria which grow in the absence of free dissolved oxygen and must obtain their oxygen by chemically breaking down organic compounds which contain combined oxygen.
AQUATIC VEGETATION:	that vegetation which will grow in or near water.

- B -

BACTERIA:	a group of universally distributed microscopic organisms lacking chlorophyll and utilizing organic nutrients as a food source.
BAR RACKS (SCREENS):	a coarse screen usually consisting of bars, equally spaced to trap roots, branches, rags and other large material that may be found in the wastewater flow.
BIOLOGICAL OXIDATION:	the process whereby living organisms in the presence of oxygen convert the organic matter in wastewater into a more stable or a mineral form.
BIOLOGY:	the science and study of living organisms, their characteristics and behavior.
BOD:	biological or biochemical oxygen demand. A test for estimation of wastewater polluting effects in terms of the oxygen requirements for bio-chemical stabilization under specified conditions of temperature and time.

- C -

CHEMOHETERO-TROPHIC:	a process of bacterial cell growth in which the organism utilizes the chemical energy derived from a breakdown of preformed complex organic substances into essential nutrients.
CHEMISTRY:	a science that deals with the composition and characteristics of substances and their behavior, i.e., transformations that they undergo.
CHLORINE:	an element having strong disinfecting and oxidizing properties in moler solution. It is commercially available as compressed gas, liquid or in combined form as a powder. It is highly toxic and irritating to skin, eyes, and lungs in significant concentration.

CHLORINATION:	the application of chlorine to water or wastewater for the purpose of disinfection, oxidation, odor control or other effects. Pre-chlorination - before treatment; post-chlorination - after treatment; in-process chlorination - during treatment.
CHLORINATION CHAMBER:	a basin or tank where chlorine is applied to the wastewater.
CHLORINE TEST:	commonly refers to one of two methods separately listed; see amperometric titration and iodometric titration.
COLIFORM GROUP:	a group of bacteria that inhabit the intestinal tract of man, warm blooded animals, and may be found in plants, soil, air and the aquatic environment. Includes aerobic and facultative gram negative non-spore forming bacilli that ferment lactose with gas formation.
COMMINUTION:	a) the act of cutting and screening materials contained in wastewaters. b) to reduce the size of fibrous or amorphous materials.

- D -

DETENTION TIME:	the theoretical time required to displace the contents of a tank or other treatment unit at a given rate of discharge.
DISCHARGE:	any flow of effluent from a treatment unit. See effluent.
DISINFECTION:	to make free of infections organisms; to kill disease organisms.
DISSOLVED OXYGEN; (D.O.)	dissolve molecular oxygen usually expressed in mg/l, ppm or percent saturation .
DIURNAL:	having a daily cycle.

- E -

EFFLUENT:	a liquid flowing out of a chamber, treatment unit or basin.

ENDPOINT:	the stage in a titration at which equivalence is attained and revealed by a change that can be observed or measured, such as color development, formation of a precipitate, meter deflection, etc.
ESCHERICHIA COLI:	a species of bacteria which are normal inhabitants of the intestine of man and other warm blooded vertebrates. See fecal coliform bacteria.

- F -

FACULTATIVE BACTERIA:	those bacteria that can adapt to aerobic or anaerobic conditions. Can utilize dissolved or combined oxygen.
FECAL COLIFORM BACTERIA:	bacterial organisms present as a result of direct fecal contamination. Those bacteria that normally inhabit the intestines of warm blooded vertebrates.
FORCEMAIN:	a pipe carrying fluid under pressure.
FREEBOARD:	the vertical distance from the water level in a flume, conduit, channel, basin or other water enclosure to the top of the confining structure.
FUNGI:	simple or complex organisms without chlorophyll. The simpler forms are one-celled; higher forms have branched filaments and complicated life cycles. Examples are molds, yeasts, and mushrooms.

- G -

GAUGE:	the action of measuring some item, such as flow, level, size, rate, etc.
GRAB SAMPLE:	a single sample not necessarily taken at a set time or flow. An instantaneous sample.
GRAVITY SYSTEM:	a system of open or closed conduits in which the liquid flows by gravity (without pumping).
GRIT:	the heavy material in water or sewage, such as sand, gravel, cinders, etc.

- H -

HEAD:	energy per unit weight of liquid at a specified point. It is expressed in feet.
HYDRAULIC LOADING:	the number of gallons per day per unit area.

- I -

IMHOFF CONE:	a cone-shaped graduated vessel used to measure the volume of settleable solids in wastewater.
INFILTRATION:	a) the entrance of ground water into a sewer through breaks, defective joints or porous walls. b) the penetration of water through the soil from surface precipitation, stream or impoundment boundaries.
INFLOW:	extraneous water entering a sanitary sewer system by direct connection from roof drains, basement sumps, manhole covers, etc.
INFLUENT:	that material entering a process unit or operation.
INORGANIC MATTER:	chemical substances of mineral origin, and not readily biodegradable..
IODOMETRIC TITRATION:	the determination of residual chlorine by addition of potassium iodide and titration of the liberated iodine with sodium thiosulfate with starch solution as a colorimetric indicator.

- M -

MEAN DEPTHS:	the average depth of water in any enclosure.
MICROBIOLOGY:	the science and study of microbiological organisms and their behavior. Commonly related to the study of pathogenic organisms.

MILLI: an expression used to indicate 1/1000 of a standard unit of weight, length or capacity (metric system).

milliliter (ml)	1/1000 liter (l)
milligram (mg)	1/1000 gram (g)
millimeter (mm)	1/1000 meter (m)

MILLIGRAMS PER LITER (MG/L): a unit of concentration on a weight/volume basis, milligrams per liter. Equivalent to ppm when the specific gravity of the liquid is 1.0.

MICROORGANISM: commonly an organism too small to be observed individually by the human eye without optical aid.

MINIMUM FLOW: those periods when wastewater flow is at its lowest peak.

MPN: (Most Probable Number): the number of bacterial organisms per unit volume which, in accordance with statistical theory, is most likely to yield the test result.

- N -

NITRIFICATION: the biochemical conversion of unoxidized nitrogen (ammonia and organic N) to oxidized nitrogen (usually nitrate).

NUTRIENTS:

a) anything essential to support life.
b) includes many common elements and combinations of them. The major nutrients include carbon, hydrogen, oxygen, nitrogen, sulfur, and phosphorus.
c) nitrogen and phosphorus are of major concern because they tend to recycle and are hard to separate because of solubility in water.

- O -

ORGANIC LOADING: the number of pounds of BOD added to a treatment unit per day.

ORGANIC MATTER:	chemical substances of animal and vegetable origin basically of carbon structure.
OUTFALL SEWER:	the outlet or channel through which wastewater effluent is discharged.
OXYGEN AVAILABLE:	that part of the oxygen available for aerobic stabilization of organic matter. Includes dissolved oxygen and that available in nitrites or nitrates, peroxides, ozone and certain other forms of oxygen.
OXYGEN DEPLETION:	the loss of oxygen from water or wastewater due to biological, chemical or physical action.

- P -

PARASITIC BACTERIA:	those bacteria which normally live off another living organism, known as the host.
PARSHALL FLUME:	a calibrated device for measuring the flow of liquid in an open conduit, consisting of a contracting length, a throat and an expanding length.
PARTS PER MILLION:	(ppm): a unit of concentration signifying parts of some substance per million parts of dispersing medium on a weight basis. Equivalent numerically to mg/l only when the specific gravity of the mixture is 1.0 example: 1 ppm = 1 pound of sugar in 1 million pounds of water (119,904 gallons)
PATHOGENIC ORGANISMS:	bacterial, fungal, viral, or other organisms directly involved with diseases of plants, animals or man are included among this group.
PEAK FLOW:	the maximum quantity of flow that occurs over a relatively short period of time.
PERCENTAGE TREATMENT:	the ratio expressed as a percentage of the material removed from process water in terms of the material entering. Sometimes referred to as reduction.

pH:	the logarithm of the reciprocal of the hydrogen-ion concentration; expresses the intensity of acidity or alkalinity.
PHOTOSYNTHESIS:	a process in which plants utilize sunlight and chlorophyll to convert carbon dioxide and inorganic substances to oxygen and additional plant material.
POLLUTION:	the addition of materials to water that produce harmful, objectionable or nuisance effects in the water. A deterioration of water quality adversely affecting subsequent uses such as the addition of sewage, industrial wastes, heat, solids, etc. This term has varied definitions depending upon the situation and the objectives.
POPULATION EQUIVALENT:	a) the calculated population which would normally contribute the same amount of biochemical oxygen demand (BOD per daY). A common base is 0.17 lb. of 5-day BOD per capita per day. b) for an industrial waste, the estimated number of people contributing sewage equal in strength to a unit volume of the waste or to some other unit involved in producing or manufacturing a particular commodity.
PRE-AERATION:	preliminary treatment of sewage comprising aeration to remove gases, add oxygen, or promote flotation of grease, and aid coagulation.
PRELIMINARY TREATMENT:	commonly considered to include bar racks, grit chambers, comminution, sedimentation and sludge digestion treatment operations. May include flocculation or disinfection.
PRIMARY TREATMENT:	the first major unit in a treatment plant which utilizes physical sedimentation to remove the greatest part of the suspended solids.
PUTREFACTION:	biological decomposition of organic matter with the production of ill-smelling products associated with anaerobic conditions.

- R -

RECORDER:	a) a device to keep a continuous or intermittant record of some measured item such as flow, velocity, applied power, etc. b) an individual who tabulates or maintains records of events, actions, or measurements.

REDUCTION:	a) to make smaller or to remove from a given amount of material. b) chemistry-the removal of oxygen, addition of hydrogen or the addition of electrons to an element or compound. c) biology-to degrade complex organic materials.
REOXYGENATION:	the replenishing of dissolved oxygen.

- S -

SALT:	a chemical compound formed as a result of the interaction of an acid and an alkali (base). The commonest salt is sodium chloride.
SANITARY SEWER:	a sewer designed to receive and to convey household, commercial or industrial wastewater mixtures.
SECONDARY TREATMENT:	commonly considered to include biochemical degradation in addition to primary treatment or in place of it. Includes trickling filtration, activated sludge, stabilization ponds, etc.
SELF-PURIFICAION:	the natural processes of purification in a moving or still body of water whereby the bacterial content is reduced, the BOD is largely satisfied, the organic content is stabilized and the dissolved oxygen returned to normal.
SAPROPHYTIC ORGANISMS:	organisms using dead or decaying organic matter as a food source.
SEPTIC WASTEWATER (SEWAGE):	wastewaters in which available oxygen has been depleted and the reduction of sulfates has begun. Anaerobic putrefaction.
SETTLEABLE SOLIDS:	those solids which will settle out when a sample of sewage is allowed to stand quietly for a one hour period.
SEWAGE:	refers to the used water of a community. Generally contaminated by the waste products from households, commercial or industrial activities. See wastewater.

SEWER:	a pipe or conduit generally covered for the purposes of conveying wastewaters from the point of origin to a point of treatment or discharge.
SEWERAGE SYSTEM:	a system of sewers and appurtenances for the collection, transportation, pumping and treating of used waters.
SHOCK LOAD:	refers to the situation where the influent contains waste of a toxic nature, of very high organic content or when the pH either drops or rises drastically. Usually detrimental to the treatment process.
SHORT CIRCUITING:	the hydraulic conditions in a tank ,chamber or basin where time of passage is less than that of the normal flow-through period.
SLUDGE BANKS:	the accumulation of solids including silt, mineral, organic and cell mass particulate material that is produced in an aquatic system.
SPRAY IRRIGATION:	a method of disposing of wastewater by spreading it on land, usually from pipes equipped with spray nozzles.
STABILIZATION:	a) the activity proceeding along the pathway to stability. b) in organic wastes, generally refers to oxidation via biochemical pathways and conversion to gaseous or insoluble materials relatively inert to further change.
STABILIZATION POND:	a secondary treatment mode in which natural purification processes occur under controlled conditions. The interaction between algae and bacteria play a vital role in this process.
STANDARD METHODS:	methods of analysis prescribed by joint action of the APHA, AWWA, and WPCF methods accepted by authority.
STERILIZATION:	the destruction of all living organisms, ordinarily through the agency of heat, chemicals or light.
SUPERSATURATION:	the situation in which water holds more oxygen at a specified temperature than normally required for saturation at that temperature.

SUSPENDED SOLIDS:	the concentration of insoluble materials suspended or dispersed in waste or used water generally expressed in mg/liter on a dry weight basis usually determined by filtration methods.

- T -

TERTIARY TREATMENT:	treatment in addition to normal or conventional secondary methods.
TITRATION:	the careful addition of a standard solution of known concentration of reacting substance to an equivalence point to estimate the concentration of a desired material in a sample.
TOTAL SOLIDS:	refers to the solids contained in dissolved and suspended form in water. Determined on weighing after drying at 103° C.
TOXIC:	a poison or acting like a poison. Something detrimental to the treatment process i.e., fuel oil, chromium salts, etc.

- V -

VOLATILE SOLIDS:	the quantity of solids in water that represent a loss in weight upon ignition at 550° C.

- W -

WASTEWATER:	refers to the used water of a community. Generally contaminated by the waste products from household, commercial or industrial activities. Often containing surface wash, storm water and infiltration waters.
WATER-BORNE DISEASE:	a disease caused by organisms or toxic substances carried by water. The most common water-borne disease are typhoid fever, asiatic cholera, polio, dysentery and other intestinal disturbances.

WEIRS:	a device used for surface overflow from a tank, basin or chamber. Generally designed to smooth out discharge flow to minimize turbulence within the detention basin. May be used to measure discharged flow.

SOURCES OF INFORMATION ON TRAINING AND CERTIFICATION

APPENDIX "B"

MINNESOTA POLLUTION CONTROL AGENCY
Facilities Section
Operator Training Unit
1935 West Co. Rd. B-2
Roseville, Minnesota 55113

SOURCES OF INFORMATION ON WASTEWATER TREATMENT FACILITY OPERATION

OPERATOR MANUALS - TREATMENT PLANT OPERATION

Manual of Wastewater Operations
Texas Water Utilities Association, 4th Edition, 1971; 2202 Indian Trail; Austin, Texas 78703. ($10.00)

Manual of Instruction for Sewage Treatment Plant Operators
Prepared by New York State Department of Health. (Referred to as New York Manual.) Write to: Health Education Service; P.O. Box 7283; Albeny, New York 12224. ($1.50)

Operator Short Course
Chanin, Gerson. Water and Wastes Engineering; 466 Lexington Ave.; New York, New York 10017. Workbook #1 ($3.00) Workbook #2 ($2.00)

Laboratory Procedures for Wastewater Treatment Plant Operators
Gilcreas, F. Wellington; 142 pages. Write to Health Education Service; P.O. Box 7283; Albany, New York 12224. ($1.25)

A Generalized Approach to Activated Sludge
Lesperance, T. W.; Water and Wastes Engineering; 466 Lexington Ave.; New York, New York 10017; 31 pages. ($3.00)

Chemical Treatment of Sewage and Industrial Wastes
Parsons, W. A.; National Lime Association; Washington, D.C. 20015; 1965, 139 pages. ($2.00)

Chlorine Manual
Chlorine Institute Inc.; 342 Madison Avenue, New York, New York 10017. ($.75) 1968

Mathematics for Wastewater Treatment Plant Operators
California Water Pollution Control Association; 2127 Ensenada Street; Lemon Grove, California 92045; 1970, ($4.50)

Lime Handling, Application and Storage in Treatment Processes
National Lime Association; 5010 Wisconsin Ave. N.W.; Washington, D.C. 20015 ($1.50)

Chlorination Guide
Water and Sewage Works; Scranton Publishing Company; 35 East Wacker Drive; Chicago, Illinois 60601 ($1.50)

Pumps and Pumping
Water and Wastes Engineering; Reuben A. Donnelley Corporation; 466 Lexington Ave.; New York, New York 10017 ($2.00)

A Primer on Wastewater Treatment
Superintendent of Documents; U.S. Government Printing Office; Washington, D.C. 20242 ($.55)

Manuals of Practice - Water Pollution Control Federation; 3900 Wisconsin Ave. N.W.; Washington, D.C. 20016.

Number	Title	WPCF Members*	Others*
MOP-1	Safety in Wastewater Works ('75), 64 pages	$ 1.00	$ 2.00
MOP-2	Sludge Utilization ('72), 48 pages	2.00	4.00
MOP-3	Regulation of Sewer Use ('75), 48 pages	1.00	2.00
MOP-4	Chlorination of Sewage and Industrial Wastes	**	**
MOP-5	Aeration in Wastewater Treatment ('71), 96 pages	3.00	6.00
MOP-6	Units of Expression for Wastes and Waste Treatment ('67), 8 pages	0.50	1.00
MOP-7	Sewer Maintenance ('66)	1.50	3.00
MOP-8	Treatment Plant Design ('57), 375 pages	3.50	7.00
MOP-9	Design and Construction of Sanitary and Storm Sewers ('69), 352 pages	5.00	10.00
MOP-10	Uniform System of Accounts for Wastewater Utilities ('71), 72 pages	2.00	4.00
MOP-11	Operation of Wastewater Treatment Plants ('70), 200 pages	2.00	4.00
MOP-12	Public Relations for Water Pollution Control ('65), 72 pages	2.00	4.00
MOP-13	Wastewater Treatment Operator Training Course One (with visual aids) ('66) Basic Course	25.00	30.00
	Publication 13 (without visual aids)	1.50	3.00
MOP-14	Wastewater Treatment Operator Training Course Two (with visual aids) Intermediate Course	40.00	50.00
	Publication 14 (without visual aids)	2.00	4.00
MOP-16	Anaerobic Sludge Digestion ('68), 60 pages	1.50	3.00
MOP-17	Paints and Protective Coatings for Wastewater Treatment Facilities ('69), 88 pages	1.50	3.00
MOP-18	Simplified Laboratory Procedures for Wastewater Examination ('69), 60 pages	2.00	4.00
MOP-19	Well of the World - a one-act play ('68)	***	***
MOP-20	Sludge Dewatering ('69), 115 pages	3.00	6.00

* Discount of 15% on orders for 12 or more copies of any one manual

** Under revision

*** 1 to 10: $3.50; 11 or more copies: $0.35 each

BOOKS - THEORY, DESIGN AND OPERATION

Microbiology of Water and Sewage
Gainey, P.L. and Lord, Thomas H.; Prentice-Hall, Inc.; Englewood Cliffs; New Jersey; 1952, 430 pages. ($9.00)

Water Quality Control Glossary
Minnesota Association of Commerce and Industry; 1600 Pioneer Building; St. Paul, Minnesota 55101. ($1.00)

Sewers for Growing America
Cohn, Morris M.; Certain-teed Products Corp.; Ambler, Pennsylvania 19002. ($10.00)

Water Supply and Sewerage
Steel, Ernest W.; 4th Edition, 1960. McGraw-Hill Book Company; 330 West 42nd Street; New York, New York 10036. ($12.50)

Chemistry for Sanitary Engineers
Sawyer, Clair N. & McCarty, Perry L.; 1960. McGraw-Hill Book Company; 330 West 42nd Street; New York, New York 10036. ($14.50)

Industrial Wastes, Their Disposal and Treatment
Rudolfe, Willem; 1953. Reinholf Publishing Corporation; 430 Park Avenue; New York, New York ($10.00)

Municipal and Rural Sanitation
Ehler, V. M. and Steel, E. W.; 6th Edition, 1965. McGraw-Hill Book Company; 330 West 42nd Street; New York, New York 10036. ($14.50)

Sewage Treatment Works, Administration and Operation
Keefer, C. E.; 1940. McGraw-Hill Book Company; 330 West 42nd Street; New York, New York 10036.

Sewage Treatment
Imhoff, Karl and Fair, G. M.; 1965. John Wiley & Sons, Inc.; 605 Third Avenue; New York, New York 10016. ($10.00)

Sewerage and Sewage Treatment
Babbit, H. E.; 8th Edition, 1958. John Wiley & Sons, Inc.; 605 Third Avenue; New York, New York 10016. ($12.95)

Laboratory Manual for Chemical and Bacterial Analysis of Water and Sewage

Theroux, F. R. and Eldridge, E. F.; 3rd Edition, 1943. McGraw-Hill Book Company; 330 West 42nd Street; New York, New York 10036. ($6.50)

Standard Methods for the Examination of Water, Sewage and Industrial Wastes
Prepared, approved, and published jointly by APHA, AWWA, and WPCF. American Public Health Association, Inc.; 1790 Broadway; New York, New York. 13th Edition, 1971. ($22.50) ($16.50 on prepaid orders for a single copy to members of the APHA, AWWA, or WPCF.)

Glossary of Water and Wastewater Terms
Produced by APHA, ASCE, AWWA, and WPCF; 387 pages. $10.00 ($7.00 to members of above organizations)

Practical Mathematics
Hobbs, McKinney, and Dalzell; American Technical Society; 848 East 58th Street; Chicago, Illinois 60637.

Elementary Theoretical Fluid Mechanics
Brenkert, K.; John Wiley & Sons, Inc.; 605 Third Avenue; New York, New York 10016.

Industrial Wastewater Discharges
Health Education Service; P.O. Box 7283; Albany, New York 12224. ($10.00)

Ten State Standards
Recommended Standards for Sewage Works; Great Lake-Upper Mississippi River Board of State Sanitary Engineers; 1971; ($1.00) Available from: Health Education Service; P.O. Box 7283; Albany, New York 12224

Water Pollution Control
Eckenfelder, W.W. and Ford, D.I.; The Pemberton Press; c/o Jenkens Publishing Company; Box 2085; Austin, Texas 78767 ($15.00)

Sewer Pipe Manual
Johns-Manville; 22 East 40th Street; New York, New York 10016 ($10.00)

Sewage Treatment - Basic Principles and Trends
Bolton, R. L. and Klein, L.; Ann Arbor Science Publishers, Inc.; P.O. Box 1425; Ann Arbor, Michigan 48106 ($14.50)

Waste Stabilization Ponds
Gloyna, E.F.; 1971; World Health Organization ($6.00)

Manual for Activated Sludge Sewage Treatment
Goodman, Brian L.; Technomic Publishing Co., Inc.; 265 West State Street; Westport, Connecticut 06880 ($15.50)

Wastewater Engineering - Collection, Treatment, Disposal
Metcalf and Eddy, Inc.; McGraw-Hill Book Company; 330 West 42nd Street; New York, New York 10036

Water Supply and Pollution Control
Clark, J. W., Viessman, W. Jr., and Hammer, Mark J.; 1971; International Textbook Company

FIELD STUDY COURSE FOR OPERATION OF WASTEWATER TREATMENT PLANTS

This course was developed by Dr. Kenneth D. Kerri, Professor of Civil Engineering, Sacramento State College, in cooperation with the California Water Pollution Control Association under a grant from the Environmental Protection Agency.

The context of the course was written by experienced operators and specifically designed to provide operators in rural areas and those unable to attend training courses with the skills and knowledge to operate wastewater treatment plants with greater efficiency and to help meet state certification requirements.

Topics covered in this sixteen-chapter course include the following:

1. The need for operators and job opportunities
2. Why wastewater must be treated
3. A description of various types of wastewater treatment plants
4. Screening, comminutors, grit removal
5. Trickling filters
6. Sedimentation and flotation
7. Activated sludge
8. Sludge digestion and handling
9. Stabilization ponds
10. Disinfection and chlorination
11. Plant maintenance
12. Plant safety and good housekeeping
13. Sampling receiving waters
14. Laboratory procedures and chemistry
15. Analysis and presentation of data
16. Records and report writing

Cost for enrollment in the program is $50.00, which includes a certificate of completion.

College credit of 6 units of extension credit is also available for an additional $54.00.
Enrollment forms are available from:

Supervisor, Operator Training Unit
Minnesota Pollution Control Agency
1935 West Co. Rd. B-2
Roseville, Minnesota 55113

Mr. Kenneth Kerri
Department of Civil Engineering
Sacramento State College
6000 Jay Street
Sacramento, California 95819

OTHER CORRESPONDENCE COURSES:

International Correspondence Schools - Scranton, Pennsylvania.
(Sewage Plant Operators Course)

Correspondence Course Manual for Wastewater Plant Operators
Second Edition, John H. Austin, PHD, Clemson University (cost $12.00)

Available from: Mr. Henry Gibson, Secretary-Treasurer
South Carolina Water Pollution Control Assn.
P.O. Box 11628
Columbia, South Carolina 29211

PERIODICALS:

Journal of the Water Pollution Control Federation
Available to members of the Central States Water Pollution Control Association.

Water and Sewage Works
Scranton Publishing Company, Inc.; 35 East Wacker Drive; Chicago, Illinois 60601. Published monthly. ($7.50 per year)

Water and Wastes Engineering
Magazine Publishing Division; Reuben H. Donnelley Corporation; 466 Lexington Avenue; New York, New York 10017. Published monthly. ($10.00 per year)

Public Works
Public Works Journal Corporation; East Stroudsburg, Pennsylvania. Published monthly. ($7.00 per year)

EDUCATIONAL OPPORTUNITIES:

Wastewater Operators Institute - Minnesota Pollution Control Agency (Annual, 2½ days)
Collection System Seminar - Minnesota Pollution Control Agency
Regional Wastewater Operator Schools - Conducted by Department of Education, Division of Vocational Education (Fundamentals of Wastewater Treatment) (20 weeks). $10.00 registration

Water Pollution Control Training Programs Environmental Protection Agency, Office of Water Programs (short-term courses, one or two weeks)

Water and Wastewater Technical School P.O. Box 370; Neosho, Missouri

Water and Wastewater Technician Course St. Cloud Vocational School, St. Cloud, Minnesota (18 months)

Further information in regard to training schools may be obtained from the Minnesota Pollution Control Agency.

ORGANIZATIONS:

Minnesota Wastewater Operators Association ($2.00)

Objectives

This organization was established in 1956, with its objective the advancement of knowledge of operation and management of wastewater treatment facilities and encouragement of a friendly exchange of information and experience. Membership is open to persons employed in the operation of wastewater treatment facilities and all others interested in the field.

Central States Water Pollution Control Federation ($25.00)
(Affiliated with the Water Pollution Control Federation)

Objectives

The object of this Association shall be the advancement of the knowledge of design, construction, operation and management of domestic and industrial wastewater treatment facilities and the encouragement of an exchange of information and experience.

OTHER SOURCES OF INFORMATION

1. Minnesota Wastewater Operators Association - quarterly regional meetings
2. Minnesota Pollution Control Agency
3. Plans and specifications of treatment plant
4. Equipment manufacturers' service bulletins
5. Water and wastewater equipment manufacturers' representatives
6. Designing engineer of plant
7. Operators of treatment plants in neighboring municipalities
8. Operation and Maintenance Manual.

Safety Training

	Cost
Safety Series I - Slides and Script	$16.50
Safety Series II - Slides and Script	16.50
Safety Series III - Slides and Script	16.50
The Safe Way - 39 Slides and Manual	11.50
Margin of Safety - 40 Slides and Manual	11.50

WPCF Safe Work Procedures Publications

No. 1	Preparations for Manholework	$0.15
No. 2	Entering and Working in Digestors	0.15

Above safety material available from: Water Pollution Control Federation
3900 Wisconsin Avenue N.W.
Washington, D.C. 20016

OPERATOR CERTIFICATION

The following is a condensed outline of the rules and regulations for the classification of water supply systems and wastewater treatment facilities and the administration of operator certification,

WWOB 1. Section (a) Purpose.

> "This regulation is intended to: (1) serve as a vehicle by which persons desiring to demonstrate their competency in the operation and maintenance of water supply systems or wastewater treatment facilities may demonstrate such competency; (2) implement the requirements of Laws of 1971, Chapter 328 (codified as Minnesota Statutes, Section 115.71 et seq.), that persons in direct responsible charge of a water supply system or wastewater treatment facility must obtain a certificate of competency from the Board in a class equal to or higher than the class of his system or facility; and (3) promote the employment of trained, experienced, reliable and efficient personnel in positions relating to the operation and maintenance of such systems and facilities, whether or not such personnel are required by these regulations to obtain proper certification. Such personnel will not only be urged to qualify for certificates for the positions they hold, but also for higher grades. Persons, firms, and corporations, either municipal or private, will be urged to employ certified operators.

(b) Definitions

(c) Severability

(d) Classification of Water Supply Systems.

Water Supply system classification is based on an accumulative point value rating system.

(e) Classification of Wastewater Treatment Facilities.

Classification of wastewater treatment facilities is based on the degree of hazard to public health, together with the type and loading of the facilities and the population served or the average population equivalent (p.e.) of the sewage handled.

This section also establishes a class "S" Treatment facility classification where the system of collection pumping and conveyance facilities are distinctly separate in operation and maintenance from the wastewater treatment facility which treats the sewage collected requiring a certified operator.

Where such conveyance facilities are under the supervision of the wastewater treatment facility operator, they are considered to be part of the treatment facility.

(f) Application, Examination and Issuance of Certificates.

Application for examination shall be made 30 days prior to the date of examination, along with the fee, for review to determine proper operator qualifications.

Examinations will be given at least once each year, and will be written with a passing grade of 70 percent, except in the case of a class A examination an oral interview also may be required.

In the event of examination failure, the applicant cannot repeat that exam for a period of six months. However, the applicant can review the examination upon request within 60 days of notification of the result.

(g) Water Supply System and Wastewater Treatment Facility Operator Qualifications.

	EDUCATION	EXPERIENCE
Class A	College Degree	3 years
	High School	7 years
Class B	College Degree	2 years
	High School	5 years
Class C	High School	3 years
Class D	Elementary	1 year
Class S-A	High School	5 years
Class S-B	High School	3 years
Class S-C	High School	2 years
Class S-D	Elementary	1 year

The above experience and/or education may be substituted for each other. However, in no event can the experience requirements be less than one year.

Certificates will be issued upon fulfillment of the requirements as outlined in WWOB 1, and shall be prominently displayed in the office of the operator or other appropriate place on the premises of the system or facility.

(h) Renewal, Reciprocity and Revocation of Operator Certificates.

All certificates shall be renewed after a period of three years if the applicant has attended approved training schools during the three-year period at least for the following number of hours:

Class A - 32 Class B - 24 Class C - 16
Class D - 8 Class S-A - 16 Class S-B - 16
Class S-C - 8 Class S-D - 8

Reciprocity certificates may be issued of an equal or lower class to a person who holds a certificate from other certification programs, provided the requirements do not conflict with the Minnesota program. However, the applicant must live in Minnesota and have a need for certification for employment in Minnesota.

(i) Schedule of Fees

Application for examination (does not include certificate)	$5.00
Issuance of certificate	5.00
Renewal of certificate	5.00
Re-examination	5.00
Reinstatement or reciprocity certificate	10.00

Fees from applicants who are rejected for examination will be returned. Fees from those failing the examination will not be returned. All fees are to be paid by check or money order and made payable to the "State Treasurer."

(j) Termination of Voluntary Certification Program.

(k) Violations.

(l) Appeals.

Copies of the complete Rules and Regulations (WOB 1) may be obtained by contacting the Minnesota Pollution Control Agency.

CREDIT FOR TRAINING SCHOOLS AND OTHER EDUCATIONAL ACTIVITIES

1. Sacramento State Correspondence Course -

   Credit for 50 hours will be given for the successful completion of this course.

2. Training courses conducted by, or in cooperation with, the Minnesota Department of Health or Minnesota Pollution Control Agency -

   Credit will be given for the successful completion, such as regional 20-week (50-hour) training schools or special water and wastewater courses.

3. Regional meetings of operator organizations - (One-half day meetings - 2 hours)
   (Full day meetings - 4 hours)
4. Annual meetings of the North Central Section American Water Works Association and Central States Water Pollution Control Association - (16 hours)
5. Annual Institute for Water Supply System Operators - (16 hours)
6. Annual Institute for Wastewater Treatment Facilities Operators - (16 hours)
7. Annual meetings of the American Water Works Association - (32 hours)
8. Annual meetings of the Water Pollution Control Federation - (32 hours)
9. In-service training activities, provided that an outline of such training is submitted to the Board for review and a determination of credit hours
10. Activated Sludge Workshop - (24 hours)
11. Stabilization Pond Operation Schools - (16 hours)

Note: a) Credit for training hours used to fulfill the requirements under Section (h)(1) for renewal cannot also be applied to the reduction of experience requirements.

b) Other training courses will be reviewed and evaluated by the Board.

APPROVED BY RESOLUTION OF THE WATER AND WASTEWATER OPERATOR BOARD OF CERTIFICATION

TABLES OF USEFUL INFORMATION AND CONVERSION TABLES

APPENDIX "C"

MINNESOTA POLLUTION CONTROL AGENCY

COMMON FORMULAS AND CONVERSION FACTORS

SYMBOLS

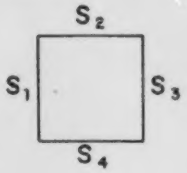
A = Area
B = Base (length of)
C = Circumference
D = Diameter
H = Height (length of)

L = Length
P = Perimeter
Q = Flow
R = Radius
S = Side (length of)

V = Volume
Vel = Velocity
W = Width (length of)
π = Pi = (3.14)
/ = Per (as gallons/day)

CALCULATIONS OF PERIMETERS

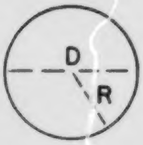
1. Rectangles or Squares: (Perimeter) $P = S_1 + S_2 + S_3 + S_4$



2. Circles:

a. $C = \pi D$

b. $C = \pi(2R)$



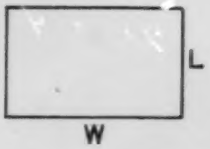
3. Other Plane Figures: P = sum of all sides

LENGTH CONVERSION FACTORS

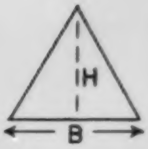
1 foot	=	12 inches		
1 yard (yd.)	=	3 feet (ft.)		
1 rod	=	5½ yards	=	16½ feet
1 chain	=	4 rods	=	66 feet
1 mile	=	5,280 feet	=	1,760 yards
1 nautical mile	=	6,076 feet		
1 meter	=	39.37 inches	=	3.281 feet

CALCULATION OF AREAS

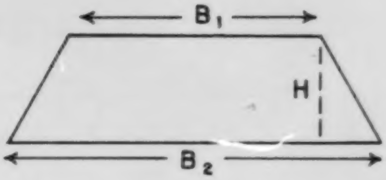
1. Square or Rectangle = $L \times W$



2. Triangle: = $\frac{1}{2} B \times H$



3. Trapezoid: = $\frac{(B_1 + B_2) \times H}{2}$

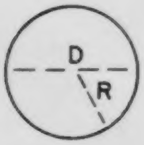


4. Circle:

a. $A = \pi R^2$

b. $A = \frac{\pi D^2}{4}$

c. $A = 0.785\ D^2$

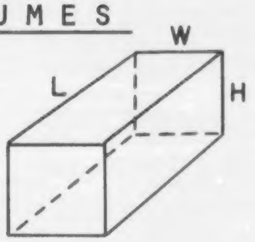


AREA CONVERSION FACTORS

1 square foot ($ft.^2$)	=	144 square inches ($inch^2$)
1 square yard ($yd.^2$)	=	9 square feet ($ft.^2$)
1 square rod ($rd.^2$)	=	272¼ square feet ($ft.^2$)
1 acre	=	43,560 square feet ($ft.^2$) = 4,840 square yards
1 square mile	=	640 acres or 1 section

CALCULATION OF VOLUMES

1. Rectangular Solids: $V = L \times W \times H$

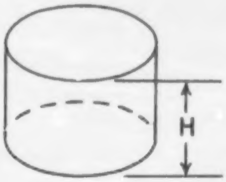


2. Cylinders:

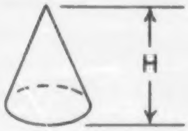
a. $V = \pi R^2 \times H$

b. $V = 0.785\ D^2 \times H$

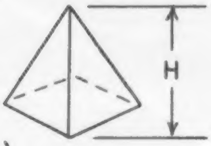
c. $V = \frac{\pi D^2 \times H}{4}$



3. Cones: $V = \frac{\pi R^2 \times H}{3}$



4. Pyramids: $V = \frac{A \times H}{3}$



(A = Area of Base)

VOLUME CONVERSION FACTORS

1 cubic foot (ft.^{3}) = 1,728 cubic inches (inch^3) = 7.5 gallons

1 cubic yard (yd.^{3}) = 27 cubic feet (ft.^{3})

1 acre foot = 43,560 cubic feet (ft.^{3}) = 325,851 gallons

1 gallon (gal.) = 231 cubic inches (inch^3) = 4 quarts

WEIGHT CONVERSION FACTORS

1 gallon = 8.34 pounds (lbs.) of water

1 cubic foot = 62.4 pounds (lbs.) of water

1 foot of water = 0.434 PSI (pounds per square inch)

1 pound (lb) = 0.454 kilograms (Kgs.)

1 kilogram (Kg) = 2.2 lbs. = 1,000 grams

1 PSI = $\frac{1}{0.433}$ ft. = 2.31 feet of water

TEMPERATURE

1. Convert Fahrenheit to Centigrade $°C. = 5/9\ (°F. - 32)$
2. Convert Centigrade to Fahrenheit $°F. = (°C. \times 9/5) + 32$

VELOCITY

1. $\text{Velocity} = \frac{\text{Distance}}{\text{Time}}$

   a. $\text{mile/h} = \frac{\text{mile}}{\text{hour}}$ b. $\text{ft/min.} = \frac{\text{feet}}{\text{minute}}$ c. $\text{ft/sec} = \frac{\text{feet}}{\text{second}}$

   (or)

   $$\text{Velocity (ft./sec.)} = \frac{\text{Flow Rate (ft.}^3\text{/sec.)}}{\text{Cross sectional area (ft.}^2\text{)}}$$

2. Gallons/Minute (GPM) = cubic ft./sec. x 60 sec./min. x 7.5 gal/ft^3

   (or)

   GPM = ft.^{3}/sec. x 60 sec./min. x 7.5 gal./ft.^{3}

3. Gallons/minute pumped =

   $$\frac{\text{volume of piston in cubic inches x revolutions/minute}}{\text{231 inches}^3\text{/gal.}}$$

   (or)

   $$\text{GPM pumped} = \frac{\pi R^2 H \times \text{RPM}}{\text{231 inch}^3\text{/gal.}}$$

VELOCITY CONVERSION FACTORS

1 cubic foot/second (CFS) = 7.5 gallons/second (GPS)
= 450 gallons/minute (GPM)

1 gallons/second = 0.133 cubic feet/second (CFS)
= 7.98 ft^3/minute

COMMONLY USED FORMULAS

1. Gallon/day (GPD) = gallons/minute (GPM) x 1,440 minutes/day
= gallons/hour (GPH) x 24 hours/day.

2. Million Gallons/Day (MGD) $= \frac{\text{gallons/day}}{1{,}000{,}000} = \frac{\text{GPD}}{1{,}000{,}000}$

3. Pounds/Day (lbs/day) = (BOD, TSS, SVS, Cl_2, etc)

lbs/day = milligrams/liter x million gallons/day x 8.34 lbs/gal

(or)

lbs/day = mg/l x MGD x 8.34 lbs/gal

(or)

lbs/day = population equivalent x population equivalent factor

4. Population Equivalent (BOD or TSS) $= \frac{\text{daily loading in pounds}}{\text{population equivalent factor}}$

5. Volume in Gallons

a. Rectangular Tank $V = L \times W \times H \times 7.5\ \text{gallons/ft}^3$

b. Circular Tank $V = \pi R^2 \times H \times 7.5\ \text{gallons/ft}^3$

$V = 0.785D^2 \times H \times 7.5\ \text{gallons/ft}^3$

6. Efficiency (% of removal) $= \frac{(\text{influent} - \text{effluent})}{\text{influent}} \times 100$

7. Detention Time $= \frac{\text{volume in gallons}}{\text{flow}}$

(or)

$$= \frac{\text{tank volume (ft}^3\text{) x 7.5 gal/ft}^3\text{ x 24 hour/day}}{\text{flow (gallons/day)}}$$

SETTLING

1. Surface Settling Rate (gallons per day per square foot)

$$= \frac{\text{flow (gallons per day)}}{\text{area (square feet)}}$$

2. Weir Overflow Rate $= \frac{\text{gallons per day flow (GPD)}}{\text{Weir length (feet)}}$

TRICKLING FILTER

1. Hydraulic Loading Rate (gal/day/ft^2) $= \frac{\text{flow in gallons per day}}{\text{surface area (square ft)}} = \frac{\text{GPD}}{\text{ft.}^2}$

(or)

$$= \frac{\text{million gallons per day}}{\text{acres}} = \frac{\text{(MGD)}}{\text{acres}}$$

2. Organic Loading Rate $= \frac{\text{BOD applied in lbs/day x 1,000 ft}^3}{\text{volume of media (ft.}^3\text{)}}$

ACTIVATED SLUDGE

1. BOD loading on aeration tank, (lbs. BOD/1,000 ft^3/day)

$$\text{lbs. BOD/1,000 ft}^3\text{/day} = \frac{\text{lbs. BOD/day x 1,000 ft}^3}{\text{volume of aeration tank (ft}^3\text{)}}$$

2. Food to Microorganism (mass) ratio (F/M)

$$\text{F/M} = \frac{\text{lbs. BOD/day}}{\text{lbs. MLSS in aeration tank}}$$

$$\text{F/M} = \frac{\text{mg/l BOD x 8.34 lbs/gal x flow (MGD)}}{\text{mg/l MLSS x 8.34 lbs/gal x vol. of tank (MG)}}$$

3. Sludge Age (SA) = Inverse of F/M:

$$SA = \frac{\text{lbs. MLSS in aeration tank}}{\text{lbs. BOD/day}}$$

$$SA = \frac{\text{mg/l MLSS x 8.34 lbs/gal x vol. of tank (MG)}}{\text{mg/l BOD x 8.34 lbs/gal x flow (MGD)}}$$

4. Sludge Volume Index (SVI)

$$SVI = \frac{\text{(ml settled in 30 minutes) x 1,000}}{\text{MLSS, mg/l}}$$

SLUDGE

1. Percent Total Solids $= \frac{\text{weight of dry (oven) sludge}}{\text{weight of wet sludge}} \text{ x } 100$

2. Percent Volatile Solids $= 100 - \left(\frac{\text{weight of material lost by burning}}{\text{weight of dry (oven) sludge}} \text{ x } 100\right)$

3. mg/l $= \frac{\text{grams x 1,000,000}}{\text{ml of sample}}$

4. Volatile Solids Reduction $= \frac{\text{(influent - effluent)}}{\text{inf - (inf x eff)}} \text{ x } 100$

STABILIZATION PONDS

1. Organic Loading on Primary Cell $= \frac{\text{influent pounds of BOD/day}}{\text{acres (primary)}}$

2. Storage Volume of a Pond =

average surface area (ft^2) x design operation depth (ft) x 7.5 gal/ft^3

3. Daily Rise in Inches =

$$\frac{\text{total flow per day (gallons) x design operating depth (inches)}}{\text{volume of pond (gallons)}}$$

STABILIZATION POND TROUBLE SHOOTING

APPENDIX "D"

TROUBLE SHOOTING

The purpose of this section is to help give you, the operator, some possible solutions, many of which have been used by operators in the state, to solve the varying problems that occur with pond systems.

1. WHAT CHEMICALS, IF ANY, SHOULD BE UTILIZED IN PROPER OPERATION OF STABILIZATION POND SYSTEMS?

General.

The need for the numerous chemicals presently on the market to enhance the operation of pond systems is not realistic. To date, many operators have been confronted by salesmen with chemicals that supposedly are designed to make ponds operate more effectively; However, in most instances, the use of such chemicals is a questionable expenditure of money. The following is a list of some common products, their uses and effectiveness.

A. Enzymes: The marketed purpose for enzymes is to enhance good biological activity and help increase efficiency. However, in a pond system which is not organically overloaded, is well operated and has good aeration action, there is no measurable advantage to using enzymes. If your system is organically overloaded and you desire to improve treatment enzymes may still not be the answer to the problem. If enzymes do help, they will only delay the actual solution to the problem. For an overloaded system, the answer is to have the problem accurately evaluated to determine the reason for overloading and then try to eliminate the problem by attacking the source. In situations where extreme difficulties with a pond system are occurring, the operator should not try to solve the problem himself. However, he should inform responsible officials of the problem and insist on a proper solution.

B. Copper Sulfate: Presently the wide acceptance of copper sulfate for algae control is realized. The questions is, should copper sulfate be used for algae control in pond systems to help bring the effluent within standards with regard to total suspended solids (TSS). The need for algae removal in some systems is apparent, but the use of copper sulfate for this purpose is questionable because numerous factors involved with the use of copper sulfate are still left unanswered. These possible problems plus the difficulty in proper application requires close evaluation and seems to indicate that the feasibility of copper sulfate as the quick easy answer to algae control does not exist. We therefore, recommend that operators do not make it a practice to use copper sulfate; however, if it is needed, proper assistance and approval should be obtained before its use.

C. Masking Agents: Should an operator use masking agents or perfumes to mask the odors that may occur on their system? Most ponds experience some odors during the spring thaw period. This odor occurrence is not unusual, usually lasts less than 10 days and represents the natural biological processes which occur. To perfume these odors each spring is generally a waste of time and money because most systems are located such that this odor does not reach or cause problems for the public. If a pond system experiences continuous odor problems, the answer is not a masking agent or perfumes, but an in depth evaluation of the source of the problem to determine the proper solution.

D. *Sodium Nitrate*: Sodium nitrate added to a pond can be beneficial to bring a system from a septic condition to a normal aerobic condition. The addition of sodium nitrate provides an increased oxygen supply and encourages recovery of a septic system to an aerobic state thereby reducing odor and increasing treatment efficiency. However, before any chemicals are added to a pond system, an evaluation of the system should be conducted by a qualified expert to determine if addition of the chemical will solve the problem or only delay its solution.

E. *Chlorination*: (*disinfection*): Chlorine is not the only mechanism to provide disinfection but it is the most easily used and readily available means to reduce the fecal coliform count. There are two widely used methods to apply chlorine to a pond for disinfection:

(1) *Batch treatment of the entire secondary pond with Calcium Hypochlorite* This does an effective job and provides adequate detention, but it is consid-

erably more costly for several reasons. First, calcium hydrochlorite is more expensive than gas chlorine and second, treating the entire secondary pond volume when you will not discharge the entire water volume is a questionable expenditure of funds.

(2) Chlorination of the effluent as it leaves the pond. This method is less costly, but it is often difficult to get adequate detention time and therefore, proper use of applied chlorine. Another problem with this procedure is that proper control of the dosage to assure consistent and adequate disinfection is difficult. Because both methods have advantages and disadvantages, the operator should determine for his system, which method will do the most adequate job.

F. Weed and Brush Sprays: Almost all pond systems at sometime will be required to reduce vegetation growth in or around the pond. The last method that should be used for weed or brush control is chemical sprays. If you have to spray, please realize that only those chemicals approved by the Department of Natural Resources should be used. In addition, you must use the proper spray for the type of vegetation you wish to control and you must adhere to the exact directions for the type of spray used if you want to get the desired control for the least amount of money. Please realize that many chemicals on the market do not do the job required. Therefore, a better product will probably cause increased saving in time and money in the long run even though the initial cost is higher.

11. POND DIKES - PROPER CARE AND PROTECTION METHODS.

A. Grasses: It is very important that the dikes have a protective cover of grass. If no grass is present, erosion and other problems because of wave action and rainfall can occur. At no time should an operator plant vegetation on the dikes which has a deep root system because the roots can destroy the compaction of the dikes. The proper type of grasses to use are the fast growing, spreading, shallow-rooted varieties. One mixture that is often utilized is the Department of Highways mixture. Grasses such as quack and brome are also very good. Whatever grasses are used, it is important to keep them cut to reduce breeding areas for insects and also to enable the operator to easily observe problems that may be developing on the dike.

B. Burrowing Animals: Animals such as muskrats, badgers, and gophers have been the cause for serious damage on many ponds. Therefore, it is important to control their presence. Gophers and badgers generally cause problems from the outside of the dike and are usually easy to detect because of the dirt mounds they leave. Muskrats on the other hand, come from the pond side and break through the seal causing leaks which can lead to major dike failure if not corrected. Proper eradication of animals should be discussed with game officials in the area to determine the best and most effective means of control. Muskrats are the leading trouble makers, but they can sometimes be controlled by preventive maintenance. If you eliminate their food source you can hopefully reduce their numbers. Therefore, control of cattails, which are a major food source for muskrats, should reduce their numbers.

C. Rip Rap: The purpose of rip rap is to stop the erosion of dikes caused by wave action and therefore secure the integrity of the pond system. There are many things that can be utilized for erosion control and it generally depends on the availability of material in a particular location. Some media that can be used for erosion control are:

(1) Rock from 3 to 15 inches in diameter, field or crushed.

(2) Scraps from brick and tile manufacturing.

(3) Rubble from demonished building and street improvement projects.

(4) Snow fence staked down on the dike in area of bad erosion may provide short term protection.

Properly used rip rap provides protection for pond dikes in numerous ways. It deters cattail and brush growth, stops muskrats from tunneling in the dike, stops erosion and protects the dike and seal. Proper location of rip rap is from one foot above the high water line to below the low water line.

III. THE FOLLOWING ARE SOME OFTEN EXPERIENCED PROBLEMS WITH PONDS AND SOME POSSIBLE SOLUTIONS THAT YOU MAY WANT TO TRY.

Situation "A" (Pipe Discharge Related)

Mr. Schlitz knows that his drawoff pipe lays on the bottom of the pond and when he discharges his pond, all the sediment is flushed out into the stream.

Possible Solution:

1. Mr. Schlitz can put a riser on the inlet end of the drawoff pipe so that the solids are not washed out.
    - (A) He can install an elbow that raises the pipe entrance one foot above the bottom.
    - (B) He can plug the end of the pipe and then knock a hole in the top of the pipe, provided it is at least 12 inches in diameter.
    - (C) He can build a wall one foot high on the apron of the pipe so the water has to go over the wall before it is discharged.

Situation "B" (Multi-Discharge Related)

Mr. Schlitz's pond system is close to hydraulic capacity and he has to discharge 70% of his present volume. However, the bottom of his ponds are all at the same elevation and in order to discharge 70% he will have to discharge the secondary more than once because he cannot get any more water in the secondary than he has in the primary. Water won't flow up-hill so he will have to partly fill the secondary several times to get out the proper amount.

Possible Solution:

1. Mr. Schlitz can pump water over the dike from the primary to secondary. That way he can fill the secondary to the five foot level and will only have to go through the discharge procedure twice.

Situation "C" (Influent Solids Buildup Related)

Mr. Schlitz has an island in the middle of his primary pond at the outlet end of the influent line.

Possible Solution:

1. Mr. Schlitz can drain the primary pond and divert the flow to the secondary, then go in with heavy equipment and remove the island.
2. A boom could be used and the solids taken out with a bucket, provided the ponds are not too large.
3. A suction line could be used to draw the sludge out if it is not too compact.

Whatever the mechanism used to remove the grit and sludge island, great care must be taken to insure that the seal is not damaged. In addition, it is important that the source of the problem be determined and eliminated so that the problem does not reoccur.

Situation "D" (Vegetation Related)

Mr. Schlitz has cattails growing out in the middle of his pond and he has to remove them to protect the seal.

Possible Solution:

1. Wait for the cattails to get to 18 inches then aerial spray them with a reliable and approved herbicide.
2. Get a cutter and attach it under a boat, then go out and cut the cattails below the water line.
3. If the reason for the cattails is low water, it may be possible to drown them by raising the water level as quickly as possible.
4. He may get a small spray rig that can be taken out in a boat and hand spray the cattails.
5. If the growth is new and the root system is not extensive, an effective way to remove it may be by pulling.

Situation "E" (Detention Time Related)

Mr. Schlitz's ponds are much too large for his present flow, therefore he can only maintain two feet of water in his ponds.

Possible Solution:

1. Allocate water from another source and bring the level up above the three foot level.
2. Stop using the secondary and only use the primary pond; however, watch the secondary pond very closely

to keep it clear of vegetation.

3. Contact the city officials and have an engineering study conducted to determine if the system should be modified.

Situation "F" (Flow Measurement Related)

Mr. Schlitz has no way to determine flow to his ponds.

Possible Solution:

1. If he knows what the daily water used by the town is he can use that figure to estimate the amount of water that goes to the ponds; depending on the time of year. This solution should only be used until a more accurate way to measure flows can be installed.
2. If he has a lift station, hour meters can be installed to determine the pumping time on the pump and then the flow can be calculated. If this mechanism is used, pumps should be calibrated frequently to insure accuracy.
3. Mr. Schlitz could have the city purchase one of the numerous flow measuring devices and have it installed in the sewer system.

Situation "H" (Flow Related)

Mr. Schlitz has a pond system which apparently is designed properly for his flows. However, he cannot keep an adequate water level.

Possible Solution:

1. His present flow measuring equipment is not accurate.
2. His ponds were not actually the size he believed they were.
3. The ponds leak.

Whatever the answer, it is up to Mr. Schlitz to confront the city officials with the possibility that the ponds do leak. Once Mr. Schlitz has checked all the possibilities and the solution to the problem is still not solved, the city should hire an engineering firm to evaluate the problem and find the solution.

Situation "I" (All Problems)

Mr. Schlitz has a problem that he cannot solve and he cannot find the answer in his pond manual.

Possible Solution:

1. Contact the Operations or Operator Training Units of the Minnesota Pollution Control Agency.
2. Contact an operator who has a pond system and possibly can give you the answer,
3. Contact the consulting engineer for the city.
4. Discuss his situation at a meeting of the Wastewater Operators Association.

What is still possibly evident by studying this manual is that not all the possible problems have been addressed or answered. Therefore we encourage you to use the possible solutions for situation "I" whenever a new problem arises. In addition, please realize that this manual will be revised from time to time and any suggestions or corrections that you may have will be appreciated.

MONTHLY OPERATION REPORT FORM — MPCA FORM 704 AND GUIDE FOR COMPLETION

APPENDIX "E"

MONTHLY OPERATION REPORT OF WASTEWATER TREATMENT FACILITY

STABILIZATION PONDS

19__

MONTH ______

DIS. NO. ______

PERMIT NUMBER ______

NAME OF FACILITY ______

TYPE OF POND (PRIMARY, SECONDARY, AERATED, ETC.)	______ POND ______ ACRES				
WEEK OF THE MONTH	1 st	2 nd	3 rd	4 th	5 th
1. DATE OF TEST OR OBSERVATION					
2. ODOR (YES OR NO)					
3. AQUATIC PLANTS (% OF COVERAGE, TYPE)					
4. FLOATING MATS (% OF COVERAGE, TYPE)					
5. POND WATER DEPTH (NEAREST INCH)					
6. MUSKRATS, RODENTS ETC. (YES OR NO)					
7. DIKE CONDITION (EROSION ETC.)					
8. ICE COVER (% OF COVERAGE)					

GENERAL			ANALYSIS — POND INFLUENT, EFFLUENT											
			INFLUENT				EFFLUENT DISCHARGE							
DATE	9 DAY OF WEEK	10 PRECIPITATION (INCHES)	11 FLOW (MGD)	12 SAMPLE TYPE	13 BOD (mg/l)	14 TSS (mg/l)	15 FLOW (MGD)	16 TIME SAMPLED	17 BOD (mg/l)	18 TSS (mg/l)	19 TURBIDITY (JTU)	20 FECAL COLIFORM (MPN/100 ml)	21 D.O. (mg/l)	22 pH (standard units)
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TOTAL				☒				☒						☒
MIN. REPORTED VALUE				☒				☒						
MIN. PERMIT CONDITION			☒	☒	☒	☒	☒	☒	☒	☒	☒	☒		
AVG. REPORTED VALUE				☒				☒						☒
AVG. PERMIT CONDITION				☒	☒	☒	☒	☒					☒	☒
MAX. REPORTED VALUE				☒				☒						
MAX. PERMIT CONDITION			☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	
REPORTED FREQUENCY OF ANALYSIS							☒	☒						
PERMIT CONDITION FREQUENCY OF ANALYSIS							☒	☒						
REPORTED SAMPLE TYPE							☒	☒						
PERMIT CONDITION SAMPLE TYPE							☒	☒						

'CA FORM 704

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NAME OF FACILITY

PHONE

Send to: MINNESOTA POLLUTION CONTROL AGENCY
1935 WEST COUNTY ROAD B2
ROSEVILLE, MINNESOTA 55113
ATTN: COMPLIANCE & ENFORCEMENT SECTION

______ POND ______ ACRES					______ POND ______ ACRES				
1st	2nd	3rd	4th	5th	1st	2nd	3rd	4th	5th

				RECEIVING WATERS DATA											
				ABOVE OUTFALL ______ MILES			BELOW OUTFALL ______ MILES			33 PRESENT CONDITION					34
23 TOTAL PHOSPHORUS AS P (mg/l)	24 KJELDAHL NITROGEN (mg/l)	25 CHLORINE USED (LBS)	26 CHLORINE RESIDUAL (mg/l)	27 TIME OF DAY	28 WATER TEMP.-°F	29 D.O. (mg/l)	30 TIME OF DAY	31 WATER TEMP.-°F	32 D.O. (mg/l)	DEPTH (ft.)	WIDTH (ft.)	VELOCITY (ft./sec.)	NORMAL + −	DATE	REMARKS INDEX
														1	
														2	
														3	
														4	
														5	
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														7	
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35. REMARKS: INCLUDE BYPASS AND OVERFLOW OCCURRENCES, UNUSUAL SEWAGE OR STREAM FLOW PROBLEMS, OPERATIONAL PROBLEMS, OTHER REQUIRED PARAMETER DATA, COMPLAINTS, ETC. IN SPACES ON BACK OF THIS FORM.

I certify that I am familiar with the information contained in this report and that to the best of my knowledge and belief such information is true, complete, and accurate.

SIGNATURE OF PRINCIPAL EXECUTIVE OFFICER OR AUTHORIZED AGENT

DATE

GENERAL						ADDITIONAL PARAMETER DATA							
DATE 1	DAY OF WEEK 2	36	37	38	39	40	41	42	43	44	45	46	47
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MINIMUM REPORTED VALUE													
MINIMUM PERMIT CONDITION													
AVERAGE REPORTED VALUE													
AVERAGE PERMIT CONDITION													
MAXIMUM REPORTED VALUE													
MAXIMUM PERMIT CONDITION													
REPORTED FREQUENCY OF ANALYSIS													
PERMIT CONDITION FREQ. OF ANALYSIS													
REPORTED SAMPLE TYPE													
PERMIT CONDITION SAMPLE TYPE													

GUIDE

for Completion of

MONTHLY OPERATION REPORT FORM

- MPCA FORM 704 -

for

WASTEWATER STABILIZATION PONDS

MINNESOTA POLLUTION CONTROL AGENCY
Operations Unit
Facilities Section
Division of Water Quality

186

APRIL 1975

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MINNESOTA POLLUTION CONTROL AGENCY

Division of Water Quality

Guide for Completing the Monthly Operation Report Form

- MPCA Form 704 -

for

Stabilization Ponds

INTRODUCTION

The following are instructions for the proper completion and submission of the required monthly operation report form for stabilization ponds. MPCA Form 704 must be submitted to the Minnesota Pollution Control Agency each month and is designed to be used by all municipal, private and commercial (non-industrial) wastewater stabilization ponds.

Form 704 eliminates the need to submit both a National Pollutant Discharge Elimination System (NPDES) report form and a Minnesota State report form each month by combining all of the reporting requirements into one form. It is hoped that this will substantially reduce the amount of paper work and confusion which resulted when each facility was required to submit two separate forms each month.

Form 704 is basically composed of five sections. The upper portion of the form is for recording your weekly observations of the depth and condition of the ponds. The three sections in the center of the form are for recording general information, receiving stream information, and all analytical tests conducted upon pond influent and effluent. The bottom portion of the form is to be used to report the NPDES permit conditions for your facility and the results of all test data for the month in a form in which it can easily be compared to your NPDES permit limitations. You will not be required to complete all five sections each month, however, it is very important that every section which is completed is filled in carefully and accurately.

In order to assist the operator in obtaining all the required information, this instruction booklet is designed to be used as a check list which the pond operator may refer to in order to determine which tests are required for his particular facility. You will notice that with the introduction to each parameter in the first four sections of this booklet there is a check box ☐ and a frequency blank. Please refer to your copy of the NPDES permit and transfer the information regarding your particular testing requirements and frequencies to these instructions so that you can use them as a convenient reference. You are not required to report any of the parameters marked "optional" unless it is required in your NPDES permit.

GENERAL INSTRUCTIONS

1. One form must be submitted for each discharge point each month. However, do not submit a separate Form 704 for bypass or overflow points.
2. In the left margin of the form enter the name and NPDES permit number of the facility; the discharge number of the discharge point being reported; and the month and year being reported. (Example: Sampleville Municipal Wastewater Treatment Facility, MN0021815, 001, June, 1975).
3. At the end of the month when all the required tests have been conducted and entered on the form, the Principal Executive Officer (Mayor, Sewer District Administrator, etc.) or his authorized agent (City Clerk, Treatment Plant Operator, etc.) must then sign the form in the signature block and enter the date the form is submitted in the date block.

I. WEEKLY OBSERVATION SECTION

This section must be completed by all pond operators and must be submitted to the MPCA every month. All observations and measurements in this section must be taken each week and recorded under the appropriate week of the month i.e., 1st week, 2nd week, etc.

Type of Pond - Enter the name of each pond in your system. There are spaces provided for three ponds, for example: Primary #1, Primary #2, Secondary. If you have more than three ponds you can probably divide this section into more parts by cutting columns in half. Also enter the size of each pond in acres.

☐ 1. Date of test or observation (Frequency weekly)

Enter the date on which your observations and/or measurements were made. For example enter May 2nd as "5/2".

☐ 2. Odors (Frequency weekly)

Enter yes or no after observing whether or not there are odors present in the vicinity of the ponds. If yes, please state the reason in the remarks section on the back of the form.

☐ 3. Aquatic Plants (Frequency weekly)

Enter an approximation of the total surface area of each pond which is covered by aquatic plants. Record this value as a percentage (%). Also enter the type of plant in the remarks section, for example "cattails".

☐ 4. Floating Mats (Frequency weekly)

Enter an approximation of the total surface area of each pond which is covered by floating sludge or algae mats. Record this value as a percentage (%). Also record the type of mats in the remarks section.

☐ 5. Pond Water Depth (Frequency weekly)

This measurement is very important and should be carefully and accurately determined for each pond each week. Pond depth should be recorded in feet and inches. For example: 3' 9". Pond depth can be accurately measured in most control or outfall structures provided you determine where the pond bottom is with respect to the bottom of the control structure.

☐ 6. Muskrats, Rodents, etc. (Frequency weekly)

Enter yes or no after visually examining both the pond surfaces and dike areas of each pond. If muskrats or other animals are observed also describe the method used to eliminate them in the remarks section on the back of Form 704.

☐ 7. Dike Condition (Frequency weekly)

Describe the condition of the dikes for each pond. Common problems to look for include erosion due to wave action, holes caused by animal burrowing, and bare spots not covered with grass. Enter "good" if there are no problems. Enter "fair", "poor" etc., if there are problems and then describe the problem and/or corrective actions taken in the remarks section on the back of Form 704.

☐ 8. Ice Cover (Frequency weekly)

Enter an approximation of the total surface area of each pond which is covered by ice. Record this value as a percentage (%).

II. GENERAL INFORMATION SECTION

This section must be completed by all pond operators on a daily basis.

☐ 9. Day of the Week. (Frequency daily)

Enter the day of the week. (M, T, W, Th, F, S, Su)

☐ 10. Precipitation in Inches. (Frequency daily)

Enter the total amount of precipitation received that day. Enter inches of either rain or snow. It is not necessary to attempt to convert snowfall to inches of rain, however please put "R" for rain and "S" for snow.

Precipitation records are helpful in determining if entry of storm water or ground water into the sanitary sewer system is a problem. Extraneous waters may cause hydraulic overloading of the treatment facility.

III. POND ANALYSIS SECTION

This section is divided into two parts. Part A is for all tests conducted upon the influent wastewater the ponds are receiving. Part B is for pond effluent and only needs to be completed prior to, and during pond discharge periods. All test results for both influent and effluent must be entered on Form 704 in the spaces provided for the day the sample was collected, not the day the sample results were received.

A. Influent

Sewage Flow - All flow measurements must be recorded in million gallons per day (mgd).

Examples: 1,000,000 gallons per day equals 1.0 mgd.

200,000 gallons per day equals 0.200 mgd.

50,000 gallons per day equals 0.050 mgd.

Rate of flow varies with the time of day, habits of the community and length of sewer system. Flow data is important because it can be used to indicate infiltration problems, calculate detention times, and allow you to properly determine how much wastewater to discharge.

Note: To convert gallons per minute (gpm) to gallons per day multiply by 1,440 minutes/day.

Example: 200 gpm x 1,440 min./day = 288,000 gallons/day or .288 mgd.

☐ 11. Influent Flow (MGD) (Frequency daily)

Record the total quantity of wastewater which enters the ponds during each 24-hour period. Any bypasses (partial or total) of the ponds should be noted in the space for remarks (such as, Bypassed 0.025 MGD). Also please indicate the time of day at which the bypass occurred and the duration of the bypass.

Note: Any bypasses must also be immediately reported to the MPCA.

☐ 12. Influent Sample Type (Frequency quarterly)

Enter the type of sample which was collected and used to determine the quarterly influent Biochemical Oxygen Demand and Total Suspended Solids tests. For example enter "grab" for a grab sample, "04C" for a 4-hour composite, and "24C" for a 24-hour composite.

Note: At least once per year the influent BOD and TSS tests must be based on a 24-hour composite sample.

5-Day BOD - 20°C - Biochemical Oxygen Demand (BOD)

BOD is the most widely accepted measure of the pollutional strength of wastewater. The BOD of normal domestic sewage is approximately 200 milligrams per liter, (mg/l) or 0.17 pounds of BOD per person per day. The BOD test is referred to as a five-day BOD because the procedure used in analysis requires a five-day incubation period in order for the results to be determined. All BOD values in Column 13 and 17 should be recorded in milligrams per liter (mg/l).

☐ 13. Influent BOD (mg/l) (Frequency quarterly)

Enter the result of the quarterly BOD test conducted upon the influent wastewater. Do not report this information on more than one monthly report form. Please try to report the results of this test on the month the test was actually conducted.

Total Suspended Solids (TSS)

The total suspended solids of normal domestic sewage is approximately 240 milligrams per liter or 0.22 pounds per person per day. All total suspended solids values should be recorded in milligrams per liter (mg/l).

☐ 14. Influent TSS (mg/l) (Frequency quarterly)

Enter the result of the quarterly total suspended solids test conducted on the influent wastewater. Do not report this information on more than one monthly report form. Try to report the results of this test on the month the test was actually conducted.

B. Effluent Discharge

This section must be used to report the results of all tests conducted both prior to, and during all pond discharge periods. Please circle the results of all tests taken prior to your discharge so that they can be distinguished from those taken during the discharge. Also enter the date you actually began discharging in the remarks section on the back of Form 704. If you do not discharge you do not need to complete this section. However, if it is not going to be necessary for you to discharge during one of your regular spring or fall discharge periods please provide an explanation for this in the remarks section on the back of the form. For every month you do not discharge please write the words "No Discharge" across this entire section (items 15-26).

☐ 15. Effluent Flow. (Frequency daily during discharge)

Enter the total quantity of stabilized wastewater which was released from the ponds during each day of your discharge period. This figure must be recorded in Million Gallons per Day (MGD) and may be determined by measuring the daily drop in pond level and then calculating the total number of gallons released that day using the following equation:

$$\frac{\begin{matrix}\text{Drop in pond depth} \\ \text{that day} \\ \text{(inches)}\end{matrix} \times \begin{matrix}\text{Size of pond} \\ \text{(average} \\ \text{acreage)}\end{matrix} \times \text{325,851 gal./acre foot}}{\text{12 inches/foot}} = \begin{matrix}\text{Total gallons} \\ \text{discharged} \\ \text{that day.}\end{matrix}$$

This should give you a reasonable approximation of the total quantity of wastewater released that day.

☐ 16. Time Sampled (Optional, but recommended)

Enter the time of day the effluent sample was collected.

☐ 17. Effluent BOD (mg/l) (Frequency once prior & 2/week during discharge)

Enter the result(s) of all effluent BOD test(s) conducted. This test must be conducted upon the contents of the final pond once prior to discharge, and upon the actual effluent twice per week during discharge.

☐ 18. Effluent TSS (mg/l) (Frequency once prior & 2/week during discharge)

Enter the result(s) of all effluent Total Suspended Solids test(s) conducted. This test must be conducted upon the contents of the final pond once prior to discharge, and upon the actual effluent twice per week during discharge.

☐ 19. Effluent Turbidity (JTU). (Frequency 2/week during discharge)

Enter the results of all turbidity tests conducted upon the effluent leaving the ponds. Turbidity is a measure of the relative visual clarity of a liquid. All turbidity values should be recorded using the standard Jackson Turbidity Units (JTU). Not all facilities are required to conduct effluent turbidity tests. Please refer to your NPDES permit to determine whether or not you must monitor and report it.

☐ 20. Effluent Fecal Coliform (MPN/100 ml). (Frequency once prior & 2/week during discharge)

Enter the results of all bacteriological testing conducted to determine the Most Probable Number (MPN) of fecal coliform organisms present in the effluent prior to, and during discharge. If you are chlorinating, the sample must be taken after the point of chlorination. This test must be conducted upon the contents of the final pond once prior to discharge, and upon the actual effluent twice per week during discharge.

Dissolved Oxygen (D.O.) (mg/l) - Pond D.O. levels can fluctuate greatly during a day depending upon the amount of sunlight received and the amount of biological activity within the pond. The D.O. content of the final effluent is an important indicator of the quality of the effluent. A pond should not be discharged if it has an extremely low D.O. because the lack of oxygen will deplete the D.O. content of the receiving stream.

☐ 21. Effluent Dissolved Oxygen (D.O.) (Frequency ______________)

Enter the result(s) of the dissolved oxygen test(s) conducted upon the effluent leaving the ponds. All dissolved oxygen values should be recorded in milligrams per liter. Pond D.O. must be tested prior to discharge and it is also recommended that you conduct D.O. tests twice/week during your discharge.

pH (Standard pH units)

Fresh, normal domestic sewage should be close to neutral depending on the character of the municipal water supply, i.e., 6.7 to 7.2. The pH of a pond can fluctuate greatly during a day depending upon the amount of sunlight it receives and the amount of biological activity within it.

☐ 22. Effluent pH (Frequency once prior & 2/week during discharge)

Enter the result(s) of all effluent pH test(s) conducted. This test must be conducted upon the contents of the final pond once prior to discharge, and upon the actual effluent twice per week during discharge.

Effluent Nutrients (mg/l)

Phosphorus and nitrogen are referred to as nutrients because they are beneficial to plant growth. All phosphorus and nitrogen values should be recorded in mg/l. Not all facilities are required to report phosphorus and nitrogen. You are only required to report effluent nutrients if your discharge is to, or directly affects a lake or reservoir. Please consult the Final Effluent Limitations section of your NPDES permit.

☐ 23. Total Phosphorus (mg/l) (Frequency 2/week during discharge)

Enter the result of the total phosphorus test conducted upon the effluent leaving the ponds. Total phosphorus content should be expressed as P, elemental phosphorus, instead of phosphate PO_4.

☐ 24. Kjeldahl Nitrogen (mg/l) (Frequency 2/week during discharge)

Enter the result of the total Kjeldahl Nitrogen test conducted upon the effluent leaving the ponds. Total Kjeldahl Nitrogen includes both organic nitrogen and ammonia.

Disinfection

You are required to use chlorine or any other means of disinfection only if fecal coliform counts are above applicable standards. If disinfection is not required then disregard columns 25 and 26.

☐ 25. Chlorine Used - Pounds (lbs.) (Frequency daily during discharge).

Enter the total number of pounds of chlorine used in the disinfection of the effluent leaving the ponds each day. If other means of disinfection are used, please note in Remarks.

☐ 26. Effluent Chlorine Residual (mg/l) - (Frequency daily during discharge)

Enter the average residual chlorine level observed in the effluent leaving the ponds each day. All residual chlorine values should be recorded in milligrams per liter (mg/l). In order to obtain residual values comparable to those of a mechanical plant all residual chlorine tests should be conducted approximately 20 minutes after receiving chlorine. This means you will have to collect a sample and wait at least 20 minutes before starting to test it.

The usual means of regulating the application of chlorine is by maintaining a specific measurable chlorine residual, however, residual chlorine can have significant toxic effects on many varieties of aquatic life. Therefore a general rule to follow if your facility does not have a specified chlorine residual limitation is to maintain only the minimum residual possible which will still allow the discharge to meet its fecal coliform limitations.

IV. RECEIVING WATERS DATA

This section only needs to be completed prior to, and during pond discharge periods.

This section is only for facilities which discharge to a river or stream. You are not required to complete this section if you discharge directly to a lake or to land application. These columns are divided into three sections. The first three columns (27-29) are for those tests conducted upon the receiving stream above the outfall from the ponds. The second three columns (30-32) are for those tests conducted upon the receiving stream below the outfall from the ponds. Above these sections a space is provided in which to record the testing site. This location should be given by recording the number of miles or parts of a mile above or below the outfall. The third section is for recording the stream conditions present at the time of discharge.

The most important test conducted upon the receiving stream is the dissolved oxygen test.

Because DO levels can fluctuate with time of day and temperature of the receiving stream it is also important to enter this information as well as the actual DO values.

If dissolved oxygen levels or present stream conditions cannot be determined because the stream bed is dry etc., please note the reason in the space provided for remarks (item #35).

☐ 27. Time of Day (Optional, but recommended).

Enter the time of day the dissolved oxygen (D.O.) test was conducted upon the receiving stream above the outfall from the ponds.

☐ 28. Water Temperature (°F). (Optional, but recommended).

Enter the water temperature in degrees Fahrenheit of the receiving stream above the outfall at the time the dissolved oxygen test was conducted.

☐ 29. Stream Dissolved Oxygen (mg/l). (Frequency once prior & 2/week during discharge).

Enter the results of all dissolved oxygen (D.O.) tests conducted upon the receiving stream above the outfall from the ponds. This test must be conducted prior to, and during all pond discharge periods.

☐ 30. Time of Day. (Optional, but recommended).

Enter the time of day the dissolved oxygen (D.O.) test was conducted upon the receiving stream below the outfall from the ponds.

☐ 31. Water Temperature (°F). (Optional, but recommended).

Enter the water temperature in degrees Fahrenheit of the receiving stream below the outfall at the time the dissolved oxygen test was conducted.

☐ 32. Stream Dissolved Oxygen (mg/l). (Frequency 2/week during discharge).

Enter the results of all dissolved oxygen (D.O.) tests conducted upon the receiving stream below the outfall from the ponds. This test must be conducted twice per week during your entire discharge period.

☐ 33. Present Stream Conditions (Optional, but recommended).

The purpose of this section is to give some indication of the total volume of water in the receiving stream at the time of discharge. These measurements should be taken just prior to, and during the discharge. All measurements should be conducted twice per week during the entire discharge period.

Depth (ft.) Enter the approximate average depth of the receiving stream immediately upstream from the outfall.

Width (ft.) Enter the approximate width of the receiving stream immediately upstream from the outfall.

Velocity (ft./sec.) Enter the approximate rate of flow of the receiving stream immediately upstream from the outfall. This measurement should be recorded in feet per second, for example 1 ft./sec.

Normal + or - Enter a plus or minus symbol to indicate whether the present stream flow is higher (+) or lower (-) than normal flow. Enter normal as "N".

REMARKS

This refers to all additional remarks, questions and comments you wish to include as part of your monthly report. Included in this category should be any bypass and overflow occurrences, unusual sewage or stream flows, operation problems, repair work, equipment breakdowns and electrical power failures, etc.

☐ 34. Remarks Index (Optional, but recommended).

The purpose of this column is to mark the date on which a particular problem occurred. Enter a mark by the appropriate day and then record the details of the problem on the back side of the report form as suggested in Item 35.

☐ 35. Remarks (Optional, but recommended).

Enter all remarks on the back side of Form 704. Please include the date on which the problem occurred and then briefly describe the situation and/or corrective actions taken.

INSTRUCTIONS FOR THE BACK OF FORM 704

The back side of Form 704 is intended to provide additional reporting columns in case the operator wishes to record any additional data for his own use or in case there are additional monitoring requirements outlined in the NPDES permit for your facility.

Most facilities are not required to report any additional parameters and need only fill in their remarks and comments on the back side of the form.

If there are additional parameters you are required to report or wish to report, you should enter the parameter names and units of measurement in the boxes at the top of the page and then record the results of all tests conducted that month. Also fill in the day of the week the test was conducted.

☐ 36-39. General (Optional)

Columns 36-39 are for your own use and may be used as you wish.

☐ 40-47. Additional Parameter Data (Frequency ________________).

Columns 40-47 are for any additional parameters required in your NPDES permit. If you report any additional parameters in these columns you should also complete the bottom portion of the form giving maximums, minimums, and permit conditions etc., as you did on the front page of the form.

V. NPDES SECTION INSTRUCTIONS

Note: All permit conditions asked for in this section may be obtained from the NPDES permit for your facility. All permit conditions, required testing frequencies, and required sample types are constants and will not need to be changed from month to month. You should enter the same information on every monthly report form for all items marked with (*). You are not required to complete the NPDES section for any column which does not have any data entered for the month.

Totals

Add up all the figures in each column except column 20 and enter the totals. For column 20 multiply all the values together and enter the product (see pages 17 and 18, step 5).

Minimum Reported Value

Read down each column and enter the smallest value recorded that month for each parameter.

Minimum Permit Condition

Effluent dissolved oxygen (D.O.) and pH are ordinarily the only two parameters which require a minimum permit condition. All municipal dischargers are normally limited to a minimum pH of 6.5. Therefore, please enter 6.5 in the corresponding box in the NPDES portion of column 22. Not all facilities have a minimum effluent D.O. requirement. If your facility does have a minimum effluent D.O. requirement please enter this information in the corresponding box for column 21. If your facility does not have a minimum effluent D.O. limitation enter NA for non-applicable.

Average Report Value

Calculate and enter the monthly average for all the test results recorded in each column except column 20. Column 20 is for fecal coliform bacterial counts which cannot be averaged in the normal manner. Fecal coliform counts require a geometric average instead of the normal arithmetic average. In order to help you determine a geometric average for the fecal coliform tests conducted during the month we have enclosed a table and instruction sheet (see page 17).

Average Permit Condition*

The average permit conditions for your facility are the NPDES effluent limitations you are required to meet. The parameters which normally have average limits are BOD_5, TSS, and fecal coliforms. For example, most stabilization ponds have average permit conditions of 25 mg/l BOD, 30 mg/l TSS, and 200 MPN/100 ml fecal coliforms. You must enter the average permit conditions for all the parameters which are limited in your NPDES permit, and enter NA in all the corresponding boxes for parameters which are not limited. Also please enter the average daily design flow for your facility in column 11 for use as a reference to see if your facility is receiving a greater flow than it was designed to handle. The average daily design flow for your ponds can be found in the facility description section of your NPDES permit.

Maximum Reported Value

Read down each column and enter the largest value recorded that month for each parameter.

Maximum Permit Condition*

Enter the maximum permit conditions specified in your NPDES permit. Ordinarily pH is the only parameter which has a maximum limitation. All municipal dischargers are normally limited to a maximum pH of 8.5. Therefore, please enter 8.5 in the corresponding box in the NPDES portion of column 22.

Reported Frequency of Analysis

Enter the actual number of times each parameter was measured during the month. Please record this by entering the number of samples per number of days each parameter was tested. For example enter: daily as 1/1, twice daily as 2/1, once per week as 1/7, twice per week as 2/7, and monthly as 1/30, etc.

---

* All Permit Conditions are listed in your NPDES permit.

Permit Condition Frequency of Analysis*

Enter the minimum frequency of analysis for each parameter as required in your NPDES permit. All stabilization ponds are required to collect and analyse two effluent samples per week during each week of their discharge period. Therefore enter "2/7" in each box.

Reported Sample Type

Enter the type of sampling which was used to collect the samples. If they were grab samples, enter GRAB. If they were composite samples, enter the number of hours composited (A 24 hour composite sample would appear as 24 C, and a 4 hour composite sample as 04C).

Permit Condition Sample Type*

Enter the sample type which is required for each parameter as specified in your NPDES permit. The present effluent monitoring requirements for all stabilization ponds call for grab samples only. Therefore enter "GRAB" in each box.

SUBMISSION OF REPORTS

All stabilization ponds are required to submit one copy of Form 704 to the Minnesota Pollution Control Agency each month. You are required by both the federal NPDES permit system and Minnesota State law to submit this report form on a regular monthly basis. Please submit the form as soon as you complete it, but at no time should this form be postmarked later than the 21st day following the month during which the monitoring was completed. For example, a report for the month of April should be sent no later than May 21st.

Note: Those facilities which were previously required to submit copies of their monthly operation report form to both the MPCA and EPA are no longer required to submit any forms to the U. S. Environmental Protection Agency in Chicago. Your only reporting requirement is to submit one Form 704 to the Minnesota Pollution Control Agency each month.

CALCULATION OF A GEOMETRIC MEAN

The following instructions and tables were designed to assist the operator in the calculation of the geometric mean for fecal coliform values. Because an exact geometric average is not completely necessary, and in order to simplify your calculations, this table was designed to give ranges rather than exact values.

The following is a step by step procedure to follow including an example for clarity.

PROBLEM: Calculate the geometric mean for the following set of fecal coliform values obtained during a one month test period at Sudsville, Minnesota.

# OF TESTS	1	2	3	4	5	6	7	8
VALUE	70	225	0	90	TNTC	< 20	325	148

STEP 1: Arrange the numbers you want to calculate the geometric mean for in order of magnitude.

# OF TESTS	1	2	3	4	5	6	7	8
VALUE	0	< 20	70	90	148	225	325	TNTC

STEP 2: Convert any values that equal zero to one.

# OF TESTS	1	2	3	4	5	6	7	8
VALUE	1	< 20	70	90	148	225	325	TNTC

STEP 3: If the value is reported as less than or greater than, use the value and remove the symbols.

# OF TESTS	1	2	3	4	5	6	7	8
VALUE	1	20	70	90	148	225	325	TNTC

STEP 4: Drop all values that are TNTC. (See Note).

# OF TESTS	1	2	3	4	5	6	7
VALUE	1	20	70	90	148	225	325

STEP 5: Multiply all values together to get a number.

1 x 20 x 70 x 90 x 148 x 225 x 325 = 1,363,646,000,000

STEP 6: Convert final number from Step 5 to scientific notation.

A. Place decimal to right of first number.

1.363646000000

B. Count off number of spaces to right of decimal.

1.363646000000

Count 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 = 12 spaces.

C. Write number as first four numbers times 10 to the power that equals the number of spaces counted in Step 6 (B).

1.363×10^{12}

STEP 7: After you have the number in scientific notation, refer to the table. Use the column which corresponds to the number of values you multiplied together (not necessarily the number of tests taken).

Sudsville Example: 7 values, so use column 7 only.

STEP 8: Look down the column until you find the number that is closest to the number you calculated. When you find the number, look to the extreme left column to find the geometric mean value closest to your number.

SMALLER = 7.812×10^{11} = 50

YOUR VALUE = 1.363×10^{12}

LARGER = 2.799×10^{12} = 60

STEP 9: Report this value in column 20 of the monthly report form as the average reported value.

A. If your value is greater than reported, add a + sign, such as 50 +.

B. If your value is less than reported, add a - sign, such as 60 -.

For example, the Sudsville final answer may be reported as either 50 + or 60 -. It is actually closest to 50 +.

NOTE: Whenever values are not used because they are TNTC, report this on the monthly report form in the remarks area and give the reason for your high values. TNTC values are only obtained from the Membrane Filter Method of analysis.

GEOMETRIC MEAN TABLE
(FOR SELECTED FECAL COLIFORM VALUES FROM 10 TO 1000)

NUMBER OF SAMPLES USED FOR DETERMINATION

GEOMETRIC MEAN [FECAL COLIFORMS (MPN/100 ml.)]	1	2	3	4	5	6	7
10	10	100	1,000	10,000	100,000	1.000 x 10^{6}	1.000 x 10^{7}
20	20	400	8,000	160,000	3.200 x 10^{6}	6.400 x 10^{7}	1.280 x 10^{9}
30	30	900	27,000	810,000	2.430 x 10^{7}	7.290 x 10^{8}	2.187 x 10^{10}
40	40	1,600	64,000	2.560 x 10^{6}	1.024 x 10^{8}	4.096 x 10^{9}	1.638 x 10^{11}
50	50	2,500	125,000	6.250 x 10^{6}	3.125 x 10^{8}	1.562 x 10^{10}	7.812 x 10^{11}
60	60	3,600	216,000	1.296 x 10^{7}	7.776 x 10^{8}	4.665 x 10^{10}	2.799 x 10^{12}
70	70	4,900	343,000	2.401 x 10^{7}	1.680 x 10^{9}	1.176 x 10^{11}	8.235 x 10^{12}
80	80	6,400	512,000	4.096 x 10^{7}	3.276 x 10^{9}	2.621 x 10^{11}	2.097 x 10^{13}
90	90	8,100	729,000	6.561 x 10^{7}	5,904 x 10^{9}	5.314 x 10^{11}	4.782 x 10^{13}
100	100	10,000	1.000 x 10^{6}	1.000 x 10^{8}	1.000 x 10^{10}	1.000 x 10^{12}	1.000 x 10^{14}
110	110	12,100	1.331 x 10^{6}	1.464 x 10^{8}	1.610 x 10^{10}	1.771 x 10^{12}	1.948 x 10^{14}
120	120	14,400	1.728 x 10^{6}	2.073 x 10^{8}	2.488 x 10^{10}	2.985 x 10^{12}	3.583 x 10^{14}
130	130	16,900	2.197 x 10^{6}	2.856 x 10^{8}	3.712 x 10^{10}	4.826 x 10^{12}	6.274 x 10^{14}
140	140	19,600	2.744 x 10^{6}	3.841 x 10^{8}	5.378 x 10^{10}	7.529 x 10^{12}	1.054 x 10^{15}
150	150	22,500	3.375 x 10^{6}	5.062 x 10^{8}	7.593 x 10^{10}	1.139 x 10^{13}	1.708 x 10^{15}
160	160	25,600	4.096 x 10^{6}	6.553 x 10^{8}	1.048 x 10^{11}	1.677 x 10^{13}	2.684 x 10^{15}
170	170	28,900	4.913 x 10^{6}	8.352 x 10^{8}	1.419 x 10^{11}	2.413 x 10^{13}	4.103 x 10^{15}
180	180	32,400	5.832 x 10^{6}	1.049 x 10^{9}	1.889 x 10^{11}	3.401 x 10^{13}	6.122 x 10^{15}
190	190	36,100	6.859 x 10^{6}	1.303 x 10^{9}	2.476 x 10^{11}	4.704 x 10^{13}	8.938 x 10^{15}
200	200	40,000	8.000 x 10^{6}	1.600 x 10^{9}	3.200 x 10^{11}	6.400 x 10^{13}	1.280 x 10^{16}
225	225	50,625	1.139 x 10^{7}	2.562 x 10^{9}	5.765 x 10^{11}	1.297 x 10^{14}	2.919 x 10^{16}
250	250	62,500	1.562 x 10^{7}	3.906 x 10^{9}	9.765 x 10^{11}	2.441 x 10^{14}	6.103 x 10^{16}
275	275	75,625	2.079 x 10^{7}	5.719 x 10^{9}	1.572 x 10^{12}	4.325 x 10^{14}	1.189 x 10^{17}
300	300	90,000	2.700 x 10^{7}	8.100 x 10^{9}	2.430 x 10^{12}	7.290 x 10^{14}	2.187 x 10^{17}
325	325	105,625	3.432 x 10^{7}	1.115 x 10^{10}	3.625 x 10^{12}	1.178 x 10^{15}	3.829 x 10^{17}
350	350	122,500	4.287 x 10^{7}	1.500 x 10^{10}	5.252 x 10^{12}	1.838 x 10^{15}	6.433 x 10^{17}
375	375	140,625	5.273 x 10^{7}	1.977 x 10^{10}	7.415 x 10^{12}	2.780 x 10^{15}	1.042 x 10^{18}
400	400	160,000	6.400 x 10^{7}	2.560 x 10^{10}	1.024 x 10^{13}	4.096 x 10^{15}	1.638 x 10^{18}
450	450	202,500	9.112 x 10^{7}	4.100 x 10^{10}	1.845 x 10^{13}	8.303 x 10^{15}	3.736 x 10^{18}
500	500	250,000	1.250 x 10^{8}	6.250 x 10^{10}	3.125 x 10^{13}	1.562 x 10^{16}	7.812 x 10^{18}
600	600	360,000	2.160 x 10^{8}	1.296 x 10^{11}	7.776 x 10^{13}	4.665 x 10^{16}	2.799 x 10^{19}
750	750	562,500	4.218 x 10^{8}	3.164 x 10^{11}	2.373 x 10^{14}	1.779 x 10^{17}	1.334 x 10^{20}
1000	1000	1.000 x 10^{6}	1.000 x 10^{9}	1.000 x 10^{12}	1.000 x 10^{15}	1.000 x 10^{18}	1.000 x 10^{21}

GEOMETRIC MEAN TABLE

(FOR SELECTED FECAL COLIFORM VALUES FROM 10 TO 1000)

GEOMETRIC MEAN [FECAL COLIFORMS (MPN/100 ML.)]	NUMBER OF SAMPLES USED FOR DETERMINATION						
	8	9	10	11	12	13	14
10	1.000×10^{8}	1.000×10^{9}	1.000×10^{10}	1.000×10^{11}	1.000×10^{12}	1.000×10^{13}	1.000×10^{14}
20	2.560×10^{10}	5.120×10^{11}	1.024×10^{13}	2.048×10^{14}	4.096×10^{15}	8.192×10^{16}	1.638×10^{18}
30	6.561×10^{11}	1.968×10^{13}	5.904×10^{14}	1.771×10^{16}	5.314×10^{17}	1.594×10^{19}	4.782×10^{20}
40	6.553×10^{12}	2.621×10^{14}	1.048×10^{16}	4.194×10^{17}	1.677×10^{19}	6.710×10^{20}	2.684×10^{22}
50	3.906×10^{13}	1.953×10^{15}	9.765×10^{16}	4.882×10^{18}	2.441×10^{20}	1.220×10^{22}	6.103×10^{23}
60	1.679×10^{14}	1.007×10^{16}	6.046×10^{17}	3.627×10^{19}	2.176×10^{21}	1.306×10^{23}	7.836×10^{24}
70	5.764×10^{14}	4.035×10^{16}	2.824×10^{18}	1.977×10^{20}	1.384×10^{22}	9.688×10^{23}	6.782×10^{25}
80	1.677×10^{15}	1.342×10^{17}	1.073×10^{19}	8.589×10^{20}	6.871×10^{22}	5.497×10^{24}	4.398×10^{26}
90	4.304×10^{15}	3.874×10^{17}	3.486×10^{19}	3.138×10^{21}	2.824×10^{23}	2.541×10^{25}	2.287×10^{27}
100	1.000×10^{16}	1.000×10^{18}	1.000×10^{20}	1.000×10^{22}	1.000×10^{24}	1.000×10^{26}	1.000×10^{28}
110	2.143×10^{16}	2.357×10^{18}	2.593×10^{20}	2.853×10^{22}	3.138×10^{24}	3.452×10^{26}	3.797×10^{28}
120	4.299×10^{16}	5.159×10^{18}	6.191×10^{20}	7.430×10^{22}	8.916×10^{24}	1.069×10^{27}	1.283×10^{29}
130	8.157×10^{16}	1.060×10^{19}	1.378×10^{21}	1.792×10^{23}	2.329×10^{25}	3.028×10^{27}	3.937×10^{29}
140	1.475×10^{17}	2.066×10^{19}	2.892×10^{21}	4.049×10^{23}	5.669×10^{25}	7.937×10^{27}	1.111×10^{30}
150	2.562×10^{17}	3.844×10^{19}	5.766×10^{21}	8.649×10^{23}	1.297×10^{26}	1.946×10^{28}	2.919×10^{30}
160	4.294×10^{17}	6.871×10^{19}	1.099×10^{22}	1.759×10^{24}	2.814×10^{26}	4.503×10^{28}	7.205×10^{30}
170	6.975×10^{17}	1.185×10^{20}	2.015×10^{22}	3.427×10^{24}	5.826×10^{26}	9.904×10^{28}	1.683×10^{31}
180	1.101×10^{18}	1.983×10^{20}	3.570×10^{22}	6.426×10^{24}	1.156×10^{27}	2.082×10^{29}	3.748×10^{31}
190	1.698×10^{18}	3.226×10^{20}	6.131×10^{22}	1.164×10^{25}	2.213×10^{27}	4.205×10^{29}	7.990×10^{31}
200	2.560×10^{18}	5.120×10^{20}	1.024×10^{23}	2.048×10^{25}	4.096×10^{27}	8.192×10^{29}	1.638×10^{32}
225	6.568×10^{18}	1.477×10^{21}	3.325×10^{23}	7.481×10^{25}	1.683×10^{28}	3.787×10^{30}	8.522×10^{32}
250	1.525×10^{19}	3.814×10^{21}	9.536×10^{23}	2.384×10^{26}	5.960×10^{28}	1.490×10^{31}	3.725×10^{33}
275	3.270×10^{19}	8.994×10^{21}	2.473×10^{24}	6.802×10^{26}	1.870×10^{29}	5.144×10^{31}	1.414×10^{34}
300	6.561×10^{19}	1.968×10^{22}	5.904×10^{24}	1.771×10^{27}	5.314×10^{29}	1.594×10^{32}	4.782×10^{34}
325	1.244×10^{20}	4.045×10^{22}	1.314×10^{25}	4.272×10^{27}	1.388×10^{30}	4.513×10^{32}	1.466×10^{35}
350	2.251×10^{20}	7.881×10^{22}	2.758×10^{25}	9.654×10^{27}	3.379×10^{30}	1.182×10^{33}	4.139×10^{35}
375	3.910×10^{20}	1.466×10^{23}	5.499×10^{25}	2.062×10^{28}	7.733×10^{30}	2.900×10^{33}	1.087×10^{36}
400	6.553×10^{20}	2.621×10^{23}	1.048×10^{26}	4.194×10^{28}	1.677×10^{31}	6.710×10^{33}	2.684×10^{36}
450	1.681×10^{21}	7.566×10^{23}	3.405×10^{26}	1.532×10^{29}	6.895×10^{31}	3.102×10^{34}	1.396×10^{37}
500	3.906×10^{21}	1.953×10^{24}	9.765×10^{26}	4.882×10^{29}	2.441×10^{32}	1.220×10^{35}	6.103×10^{37}
600	1.679×10^{22}	1.007×10^{25}	6.046×10^{27}	3.627×10^{30}	2.176×10^{33}	1.306×10^{36}	7.836×10^{38}
750	1.001×10^{23}	7.508×10^{25}	5.631×10^{28}	4.223×10^{31}	3.167×10^{34}	2.375×10^{37}	1.781×10^{40}
1000	1.000×10^{24}	1.000×10^{27}	1.000×10^{30}	1.000×10^{33}	1.000×10^{36}	1.000×10^{39}	1.000×10^{42}